Agriculture
Canada

RESEARCH BRANCH REPORT

1983

RAPPORT DE LA DIRECTION GÉNÉRALE DE LA RECHERCHE

AGRICULTURE CANADA
CODE 17 S [illegible] ISSUE
[illegible] 98 [illegible]

630.7
C212
CANADA
Research
Br.
R 1983
c.3

Canada

Digitized by the Internet Archive
in 2013

http://archive.org/details/researchbranchre1983cana

Research Branch Report

1983

Rapport de la Direction générale de la recherche

RESEARCH BRANCH
DIRECTION GÉNÉRALE DE LA RECHERCHE

AGRICULTURE CANADA

Copies of this publication are available from

Research Program Service
Research Branch
Agriculture Canada
Ottawa, Ont.
K1A 0C6

On peut obtenir des exemplaires de cette publication au

Service aux programmes de recherche
Direction générale de la recherche
Agriculture Canada
Ottawa (Ont.)
K1A 0C6

©Minister of Supply and Services Canada 1984
Cat. No. A51-1/1983
ISBN 0-662-53198-1
Printed 1984

©Ministre des Approvisionnements et Services Canada 1984
N^{o} de cat. A51-1/1983
ISBN 0-662-53198-1
Impression 1984

CONTENTS

Executive of the Research Branch, v *L'exécutif de la Direction générale de la recherche,* v
Program Coordination Directorate, vii *Direction de la coordination du programme,* vii
Administration Division, viii *Division de l'administration,* viii
Branch Financial Management, viii *Gestion financière de la Direction générale,* viii
Map of research establishments, ix *Carte des établissements de recherche,* ix
Organization of the Research Branch, x *Organisation de la Direction générale de la recherche,* xi
Foreword, xii *Avant-propos,* xiii

INSTITUTES DIRECTORATE *DIRECTION DES INSTITUTS* 1
- Biosystematics Research Institute, 7
- Chemistry and Biology Research Institute, 23
- Engineering and Statistical Research Institute, 37
- Food Research Institute, 49
- Land Resource Research Institute, 63
- Research Program Service, 81

ATLANTIC REGION *RÉGION DE L'ATLANTIQUE* 85
- St. John's West, Nfld., 91
- Charlottetown, P.E.I., 97
- Kentville, N.S., 109
- Fredericton, N.B., 125

QUEBEC REGION *RÉGION DU QUÉBEC* 137
- Centre de recherches alimentaires, Saint-Hyacinthe, Québec, 143
- Lennoxville, Québec, 145
- Sainte-Foy, Québec, 155
- Saint-Jean-sur-Richelieu, Québec, 169

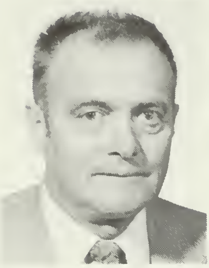
ONTARIO REGION *RÉGION DE L'ONTARIO* 177
- Animal Research Centre, 183
- London Research Centre, 207
- Delhi, Ont., 219
- Harrow, Ont., 225
- Ottawa, Ont., 237
- Vineland Station, Ont., 255

PRAIRIE REGION *RÉGION DES PRAIRIES* 265
- Brandon, Man., 271
- Morden, Man., 279
- Winnipeg, Man., 285
- Melfort, Sask., 301
- Regina, Sask., 307
- Saskatoon, Sask., 315
- Swift Current, Sask., 325
- Beaverlodge, Alta., 335
- Lacombe, Alta., 341
- Lethbridge, Alta., 349

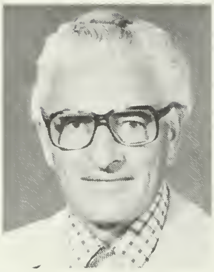
PACIFIC REGION *RÉGION DU PACIFIQUE* 369
- Agassiz, B.C., 375
- Kamloops, B.C., 381
- Saanichton Research and Plant Quarantine Station, B.C., 387
- Summerland, B.C., 393
- Vancouver, B.C., 405

Program Structure, 415 *Structure du programme,* 418

Dr. E. J. LeRoux



Dr. R. L. Halstead

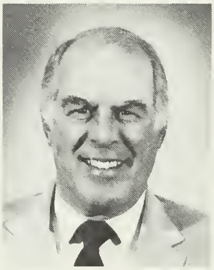


Dr. J. W. Morrison

Dr. E. E. Lister

Mr. J.-J. Jasmin

Dr. J. J. Cartier



Dr. W. L. Pelton

Dr. W. Baier

Dr. J. E. Andrews

Mr. J. E. Ryan

Mr. J. E. Renaud

EXECUTIVE OF THE RESEARCH BRANCH
L'EXÉCUTIF DE LA DIRECTION GÉNÉRALE DE LA RECHERCHE

Assistant Deputy Minister, Research
Sous-ministre adjoint à la Recherche

E. J. LeRoux, B.A., M.Sc., Ph.D.

Directors General/*Directeurs généraux*

Program Coordination/*Coordination du programme*	R. L. Halstead, B.S.A., Ph.D.
Institutes/*Instituts*	J. W. Morrison, B.Sc., M.Sc., Ph.D
Atlantic Region/*Région de l'Atlantique*	E. E. Lister, B.Sc., M.Sc., Ph.D.
Quebec Region/*Région du Québec*	J.-J. Jasmin, B.Sc. (Agr.), M.Sc.
Ontario Region/*Région de l'Ontario*	J. J. Cartier, B.A., B.Sc., Ph.D.
Prairie Region/*Région des Prairies*	W. L. Pelton, B.S.A., M.S.A., Ph.D.
Pacific Region, Acting/*Région du Pacifique, intérimaire*	W. Baier, Diplomlandwirt, Dr.Agr., M.S.

Senior Adviser/*Conseiller principal*

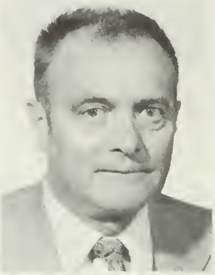
Special projects/*Projets spéciaux*	J. E. Andrews, B.S.A., M.S.A., Ph.D.

Director/*Directeur*

Administration Division/*Division de l'administration*	J. E. Ryan, A.C.B.A., R.I.A.

Manager/*Gestionnaire*

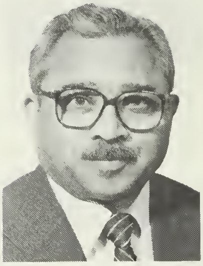
Branch Financial Management/*Gestion financière de la Direction générale*	J. E. Renaud, C.D.



Dr. R. L. Halstead

Dr. R. Bouchard

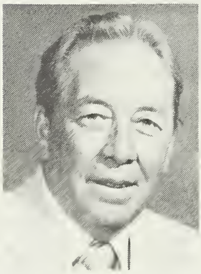
Dr. W. J. Saidak



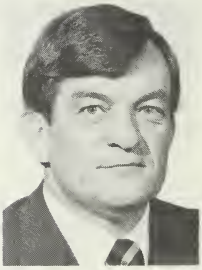
Dr. M. R.
Sahasrabudhe

Mr. D. Kirkland

Dr. C. J. Bishop



Mr. R. M. Prentice



Mr. J. Nowland

Dr. J. R. Aitken

PROGRAM COORDINATION DIRECTORATE
DIRECTION DE LA COORDINATION DU PROGRAMME

Director general
Directeur général

R. L. Halstead, B.S.A., Ph.D.

Research Coordinators/*Coordonnateurs de la recherche*

Animals/*Animaux*	R. Bouchard, B.A., B.S.A., M.Sc., Ph.D.
Crops/*Cultures*	W. J. Saidak, B.S.A., M.S., Ph.D.
Food, Acting/*Aliments, intérimaire*	M. R. Sahasrabudhe, B.Sc., M.Sc., Ph.D.
International research and development, Acting/*Recherche et développement à l'échelle internationale, intérimaire*	D. Kirkland
Production/*Production*	C. J. Bishop, B.Sc., A.M., Ph.D., F.R.S.C.
Protection/*Protection*	R. M. Prentice, B.Sc., M.Sc.
Resources, Acting/*Ressources, intérimaire*	J. Nowland, B.A., M.Sc.

Analysts/*Analystes*

Contracts/*Contrats*	J. R. Aitken, B.S.A., M.Sc., Ph.D.

Special Advisers/*Conseillers spéciaux*

Accountability/*Imputabilité*	J. A. Perrin, B.Sc.
Accountability/*Imputabilité*	R. S. Bush, B.S.A., M.Sc., Ph.D.
Animals/*Animaux*	J. R. Lessard, B.A., B.Sc., M.S., Ph.D.
Crops/*Cultures*	J. Mulders, B.A., B.Sc., M.S., Ph.D.
Production/*Production*	J. M. Deschênes, B.S.A., M.Sc., Ph.D.
Program Analysis/*Analyse du programme*	K. W. Lievers, B.Sc., M.Sc.
Resources/*Ressources*	M. K. John, B.Sc. (Ag.), M.S., Ph.D.

ADMINISTRATION DIVISION
DIVISION DE L'ADMINISTRATION

Director
Directeur

J. E. Ryan, A.C.B.A., R.I.A.

Acting Chief, Administration Section
Chef intérimaire, Section de l'administration

H. D. Brannen

Chief, Human Resources Section
Chef, Section des ressources humaines

G. J. Redmond

BRANCH FINANCIAL MANAGEMENT
GESTION FINANCIÈRE DE LA DIRECTION GÉNÉRALE

Manager
Gestionnaire

J. E. Renaud,[1] C.D.

Chief, Financial planning
Chef, Planification financière

K. Archer,[1] R.I.A.

Chief, Financial analysis
Chef, Analyse financière

A. L. Dignard[1]

Chief, Financial planning and analysis (Institutes and Ontario)
Chef, Planification et analyse financières (Instituts et Ontario)

J. B. Moran[1]

---

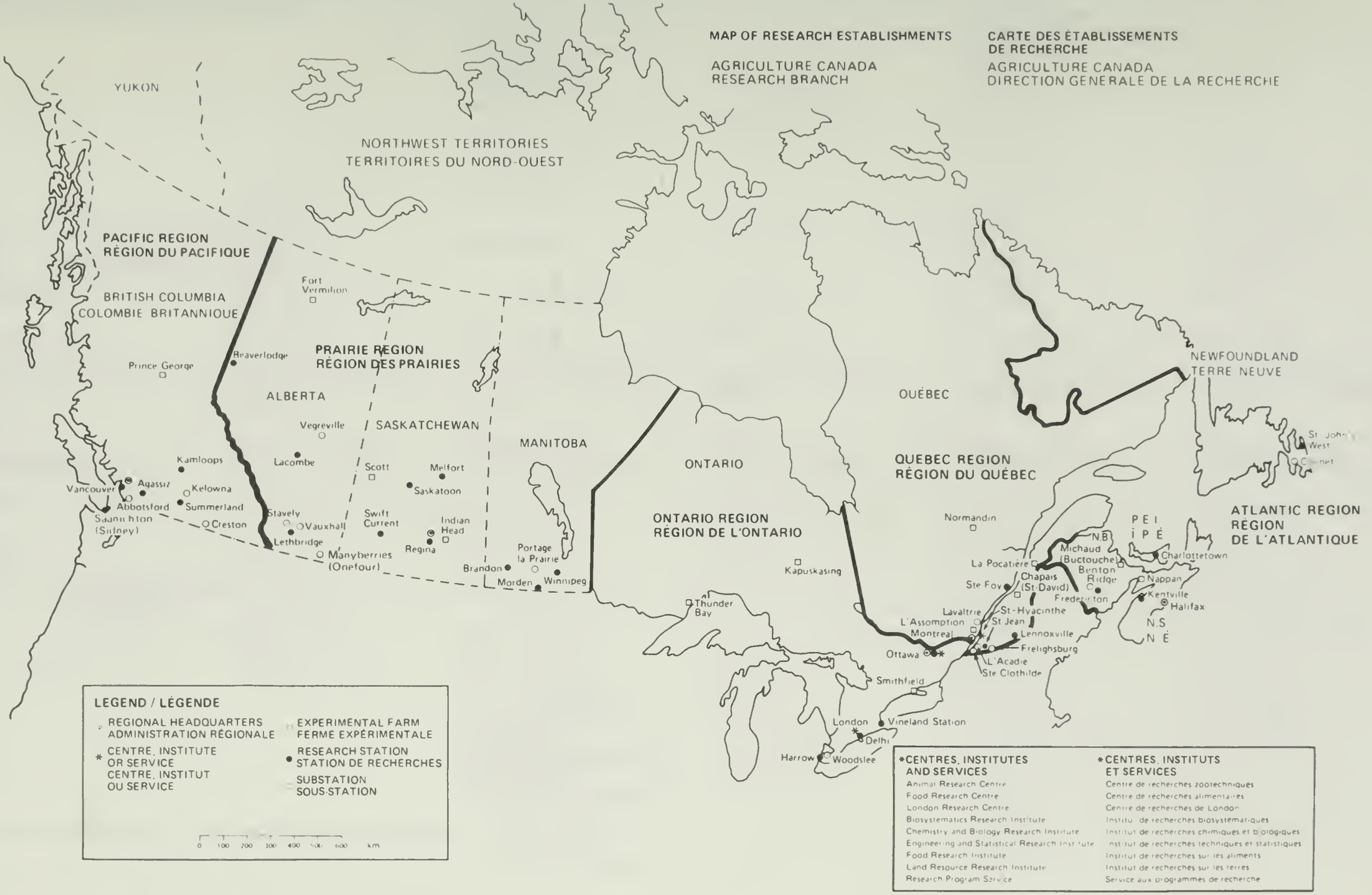
[1] Seconded from Finance and Administration Branch/*Détaché de la Direction générale des finances et de l'administration.*

MAP OF RESEARCH ESTABLISHMENTS

AGRICULTURE CANADA
RESEARCH BRANCH

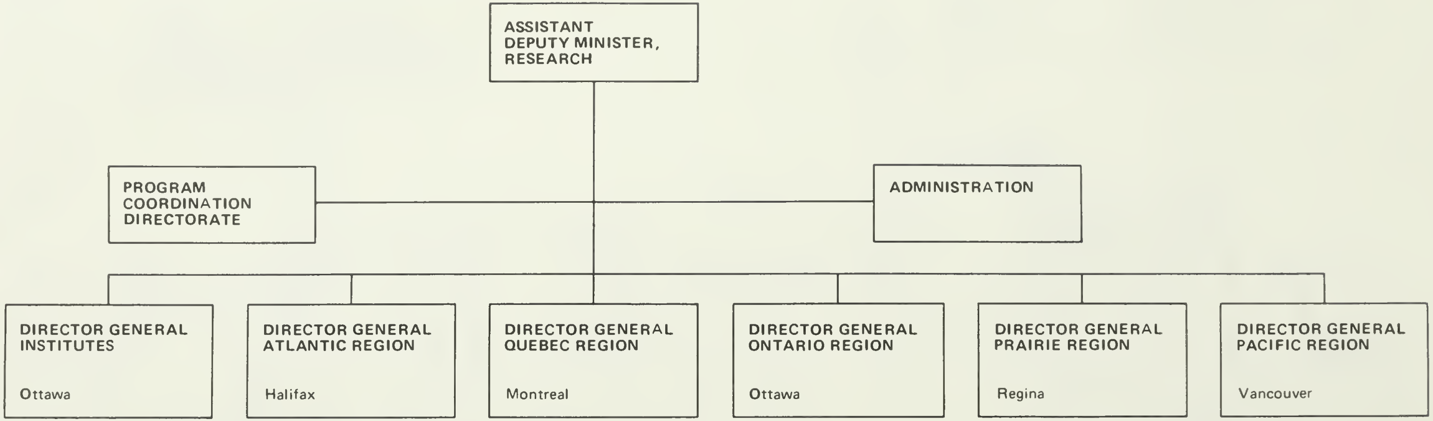
CARTE DES ÉTABLISSEMENTS DE RECHERCHE

AGRICULTURE CANADA
DIRECTION GENERALE DE LA RECHERCHE



*CENTRES, INSTITUTES AND SERVICES	*CENTRES, INSTITUTS ET SERVICES
Animal Research Centre	Centre de recherches zootechniques
Food Research Centre	Centre de recherches alimentaires
London Research Centre	Centre de recherches de London
Biosystematics Research Institute	Institut de recherches biosystematiques
Chemistry and Biology Research Institute	Institut de recherches chimiques et biologiques
Engineering and Statistical Research Institute	Institut de recherches techniques et statistiques
Food Research Institute	Institut de recherches sur les aliments
Land Resource Research Institute	Institut de recherches sur les terres
Research Program Service	Service aux programmes de recherche

ORGANIZATION OF THE RESEARCH BRANCH


ASSISTANT DEPUTY MINISTER, RESEARCH
PROGRAM COORDINATION DIRECTORATE
ADMINISTRATION
DIRECTOR GENERAL INSTITUTES
Ottawa
DIRECTOR GENERAL ATLANTIC REGION
Halifax
DIRECTOR GENERAL QUEBEC REGION
Montreal
DIRECTOR GENERAL ONTARIO REGION
Ottawa
DIRECTOR GENERAL PRAIRIE REGION
Regina
DIRECTOR GENERAL PACIFIC REGION
Vancouver

Research Institutes

Biosystematics
Chemistry and Biology
Engineering and Statistical
Food
Land Resource

Research Program Service

Research Stations

St. John's West, Nfld.
    Colinet, Nfld.
Charlottetown, P.E.I.
Kentville, N.S.
    Nappan, N.S.
Fredericton, N.B.
    Benton Ridge, N.B.
    Michaud
        (Buctouche), N.B.

Research Centre

Food, Saint-Hyacinthe, Que.

Research Stations

Lennoxville, Que.
Sainte-Foy, Que.
    La Pocatière, Que.
    Normandin, Que.
    Chapais
        (Saint-David), Que.
Saint-Jean, Que.
    Frelighsburg, Que.
    L'Acadie, Que.
    L'Assomption, Que.
    Lavaltrie, Que.
    Sainte-Clothilde, Que.

Research Centres

Animal, Ottawa, Ont.
London, Ont.

Research Stations

Delhi, Ont.
Harrow, Ont.
    Woodslee, Ont.
Ottawa, Ont.
    Kapuskasing, Ont.
    Thunder Bay, Ont.
Vineland Station, Ont.
    Smithfield, Ont.

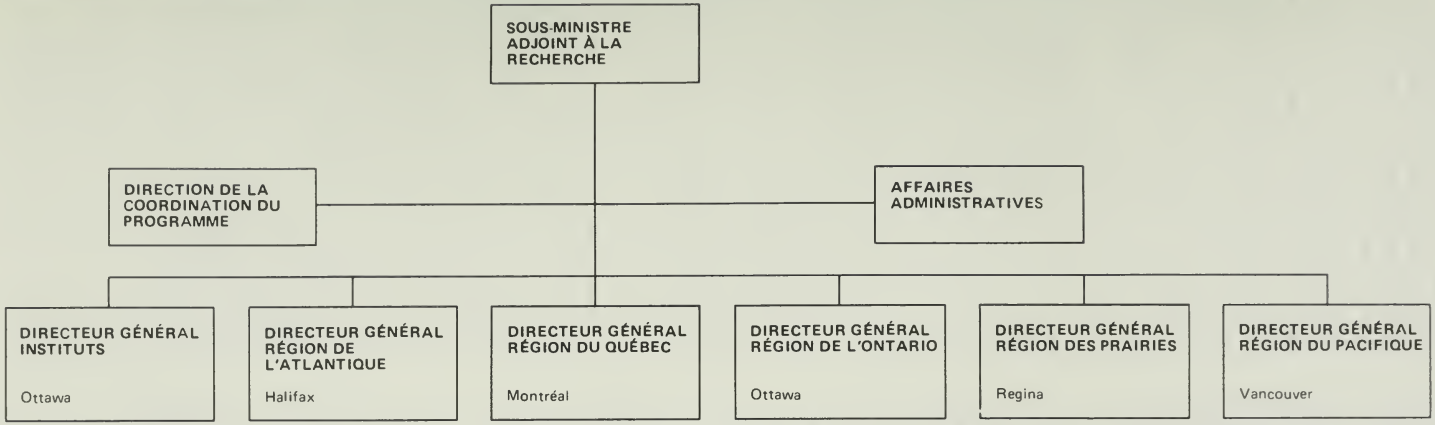
Research Stations

Brandon, Man.
Morden, Man.
    Portage la Prairie, Man.
Winnipeg, Man.
Melfort, Sask.
Regina, Sask.
    Indian Head, Sask.
Saskatoon, Sask.
    Scott, Sask.
Swift Current, Sask.
Beaverlodge, Alta.
    Fort Vermilion, Alta.
Lacombe, Alta.
    Vegreville, Alta.
Lethbridge, Alta.
    Manyberries
        (Onefour), Alta.
    Stavely, Alta.
    Vauxhall, Alta.

Research Stations

Agassiz, B.C.
    Abbotsford, B.C.
Kamloops, B.C.
    Prince George, B.C.
Saanichton Research
    and Plant Quarantine
    Station (Sidney), B.C.
Summerland, B.C.
    Creston, B.C.
    Kelowna, B.C.
Vancouver, B.C.

ORGANISATION DE LA DIRECTION GÉNÉRALE DE LA RECHERCHE


SOUS-MINISTRE ADJOINT À LA RECHERCHE
DIRECTION DE LA COORDINATION DU PROGRAMME
AFFAIRES ADMINISTRATIVES
DIRECTEUR GÉNÉRAL INSTITUTS
Ottawa
DIRECTEUR GÉNÉRAL RÉGION DE L'ATLANTIQUE
Halifax
DIRECTEUR GÉNÉRAL RÉGION DU QUÉBEC
Montréal
DIRECTEUR GÉNÉRAL RÉGION DE L'ONTARIO
Ottawa
DIRECTEUR GÉNÉRAL RÉGION DES PRAIRIES
Regina
DIRECTEUR GÉNÉRAL RÉGION DU PACIFIQUE
Vancouver

Instituts de recherche

- Aliments
- Biosystématique
- Chimie et biologie
- Technique et statistique
- Terres

- Service aux programmes de recherche

Stations de recherche

- Saint-Jean (T.-N.)
  - Colinet (T.-N.)
- Charlottetown (Î.-P.-É.)
- Kentville (N.-É.)
  - Nappan (N.-É.)
- Frédéricton (N.-B.)
  - Benton Ridge (N.-B.)
  - Michaud (Buctouche) (N.-B.)

Centre de recherche

- Aliments (Saint-Hyacinthe) (Québec)

Stations de recherche

- Lennoxville (Québec)
- Sainte-Foy (Québec)
  - La Pocatière (Québec)
  - Normandin (Québec)
  - Chapais (Saint-David) (Québec)
- Saint-Jean (Québec)
  - Frelighsburg (Québec)
  - L'Acadie (Québec)
  - L'assomption (Québec)
  - Lavaltrie (Québec)
  - Sainte-Clothilde (Québec)

Centres de recherche

- London (Ont.)
- Zootechnie (Ottawa) (Ont.)

Stations de recherche

- Delhi (Ont.)
- Harrow (Ont.)
  - Woodslee (Ont.)
- Ottawa (Ont.)
  - Kapuskasing (Ont.)
  - Thunder Bay (Ont.)
- Vineland Station (Ont.)
  - Smithfield (Ont.)

Stations de recherche

- Brandon (Man.)
- Morden (Man.)
  - Portage-la-Prairie (Man.)
- Winnipeg (Man.)
- Melfort (Sask.)
- Regina (Sask.)
  - Indian Head (Sask.)
- Saskatoon (Sask.)
  - Scott (Sask.)
- Swift Current (Sask.)
- Beaverlodge (Alb.)
  - Fort Vermilion (Alb.)
- Lacombe (Alb.)
  - Végreville (Alb.)
- Lethbridge (Alb.)
  - Manyberries (Onefour) (Alb.)
  - Stavely (Alb.)
  - Vauxhall (Alb.)

Stations de recherche

- Agassiz (C.-B.)
  - Abbotsford (C.-B.)
- Kamloops (C.-B.)
  - Prince George (C.-B.)
- Station de recherche et de quarantaine des plantes de Saanichton (Sidney) (C.-B.)
- Summerland (C.-B.)
  - Creston (C.-B.)
  - Kelowna (C.-B.)
- Vancouver (C.-B.)

FOREWORD

The programs of the Research Branch are designed to serve the agri-food industry. Priorities are determined through direct consultation with industry and are outlined in the Departmental agri-food strategy for Canada, which is updated annually.

The success of the agri-food strategy in the 1980s and 1990s depends on the development of new technology through research. Therefore, the research programs that will be emphasized include studies on our land resource base, on the application of new techniques for increasing the efficiency of producing crops and animals on Canadian farms, and on finding ways to improve food processing and quality.

To support these practical programs, basic research is expanding in such high-priority areas as biotechnology and toxic chemicals. Research in biotechnology is expected to produce improved pest-resistant cultivars, to result in efficient biological control of insects and weeds, to enhance nitrogen fixation in cereals and other crops and thereby reduce the requirements for nitrogen fertilizers, and to facilitate the use of enzymes and microorganisms in fermentation processes. Biotechnological techniques are valuable because they are energy-saving, economical, and environmentally clean. Research in toxic chemicals is currently focusing on detecting their presence in primary agricultural products, determining their effects on animal and human health, and finding ways to reduce or eliminate them from food products.

In 1983, the research establishments of the Branch published 1014 scientific and 530 miscellaneous papers. Sixteen soil reports were published and 20 additional reports are ready for publication. The Research Branch developed 35 cultivars for licensing or release in 1983. Some 75% of the cultivars increased and distributed by the SeCan Association were developed by the Research Branch of Agriculture Canada. New developments were conveyed to the agriculture and food industry through provincial extension services, seminars, committees, and direct contacts. The contributions of the Research Branch to the Canadian agri-food industry were highlighted at the 1983 Canadian Agricultural Outlook Conference, where I had the privilege of speaking to the participants about the achievements made by the Branch over the past 10 years.

In 1983 the Research Branch had a staff of 3622, of which 916 were professionals, and administered a budget of $220 million, an increase of $20 million from the main estimates. Most of this increase was allocated to the Western Grain Research Foundation, the Summer Canada program, the new employment expansion and development (NEED) program, and contract research on energy and biotechnology. The Branch also administered a $12 million contract program directed primarily to energy, food processing, mechanization, and toxic chemicals. Under the capital strategy plan the Branch spent $18.5 million in 1983 for the construction or improvement of laboratories and research facilities. Top priorities, either under way or planned, include the Saint-Jean office-laboratory facilities, the Food Research Centre at Saint-Hyacinthe, and facilities at Fredericton, Lennoxville, London, Morden, Lethbridge, Beaverlodge, Summerland, and Agassiz.

The Branch has contributed substantially to the international activities of Agriculture Canada, specifically by helping to develop markets for Canadian agricultural products. Scientific exchanges under memoranda of understanding and other types of signed agreements included those with Yugoslavia, Russia, China, Romania, Belgium, France, Israel, India, Pakistan, Sri Lanka, Japan, Tanzania, Kenya, Brazil, Venezuela, and Mexico. International agencies and working groups also continue to use the scientific and technical expertise of the Branch in their own agriculture exchange programs.

The Branch cooperated with other branches of the Department in areas such as policy review, strategic planning, and programs dealing with regulation of blue mold in tobacco, potato ring rot, and mycotoxins. The development committees of Agriculture Canada have successfully worked to prepare federal agricultural strategies in most provinces. Interdepartmental activities have led to the development of various national strategies and programs: in biotechnology, with the National Research Council of Canada; in crop information systems, with Energy, Mines, and Resources Canada; and in climate, acid rain, land resources, pesticides, and mycotoxins, with Environment Canada and other involved departments.

An A-base review of programs was completed in 1983. It will be used by the Department to inform Treasury Board, the Ministry of State for Economic and Regional Development, and the Ministry of State for Science and Technology of the substantial economic benefits accrued from achievements in agri-food research. It describes the return on investment from these programs and supports the need for research resources over the next decade to provide the new technology essential to the agri-food sector.

E. J. LeRoux

AVANT-PROPOS

Les programmes de la Direction générale de la recherche sont conçus pour répondre aux besoins du secteur agro-alimentaire. Leurs priorités, établies après consultation avec le secteur agricole, se trouvent dans la Stratégie agro-alimentaire mise à jour chaque année.

Le développement d'une nouvelle technologie par la recherche est essentiel au succès de la Stratégie agro-alimentaire dans les années 80 et 90. Les défis de cette stratégie ne seront relevés qu'en encourageant la recherche sur les ressources des terres; l'accroissement de l'efficacité de la production végétale et animale à la ferme grâce à l'application de nouvelles techniques; et la transformation et la qualité des aliments.

Pour appuyer les programmes de recherches thématiques, des efforts soutenus porteront sur des secteurs fondamentaux hautement prioritaires comme la biotechnologie et les produits toxiques. Les réalisations prévues en biotechnologie comprennent le développement de cultivars améliorés qui résistent aux parasites, la lutte biologique contre les insectes et les mauvaises herbes, la création de cultivars de céréales et d'autres cultures capables de fixer l'azote atmosphérique afin de réduire les besoins en engrais azotés et de faciliter l'utilisation d'enzymes et de micro-organismes dans les processus de fermentation. De nouvelles techniques dérivées de la recherche en biotechnologie seront précieuses, car ces méthodes sont économiques en terme d'énergie et non polluantes. La recherche porte également sur la présence de composés toxiques dans les produits agricoles primaires, leurs effets sur la santé humaine et animale, et leur réduction ou leur élimination dans les produits alimentaires.

Au cours de 1983, les établissements de recherches de la Direction générale ont publié 1 014 études scientifiques et 530 documents divers. Le personnel de ces établissements a transmis ces connaissances aux producteurs et aux transformateurs des aliments par l'entremise des services provinciaux de vulgarisation, de publications, de conférences, de comités et en communiquant directement avec les agriculteurs. Seize rapports pédologiques ont été publiés et 20 rapports sont prêts pour publication. La Direction générale a créé 35 cultivars destinés à l'homologation ou à la diffusion en 1983. Depuis la fondation de l'Association SeCan en 1976, 75% des cultivars multipliés et distribués par cette association ont été créés par la Direction générale de la recherche. Ces réalisations concrètes de même que celles citées dans cette publication ont des répercussions directes sur l'efficacité et la protection de la production agricole. La contribution de la Direction générale de la recherche à l'industrie agro-alimentaire canadienne a été soulignée lors de la conférence des perspectives de l'agriculture canadienne où j'ai eu le privilège d'énumérer nos réalisations au cours des 10 dernières années.

En 1983, la Direction générale de la recherche comptait un personnel de 3 622 employés, dont 916 professionnels et disposait d'un budget de 220 millions de dollars ce qui représente une augmentation de 20 millions de dollars sur les prévisions budgétaires. Ce supplément budgétaire a été réparti comme suit: la Fondation de recherche sur les grains de l'Ouest, le programme d'Été Canada et le programme de Relance de l'aide à l'emploi (RELAIS), la recherche à contrat sur l'énergie et la biotechnologie. La Direction générale a aussi administré un programme contractuel de $12 millions de dollars consacré surtout à la transformation des aliments, à l'automatisation et aux composés toxiques. Dans le cadre du Plan d'immobilisation, en 1983, la Direction générale a dépensé $18,5 millions de dollars pour la construction ou l'amélioration des installations de recherches. Les principaux projets comprennent des laboratoires et des bureaux à Saint-Jean; le centre de recherches sur les aliments à Saint-Hyacinthe; la construction ou l'amélioration des installations à Fredericton, Lennoxville, London, Morden, Lethbridge, Beaverlodge, Summerland et Agassiz.

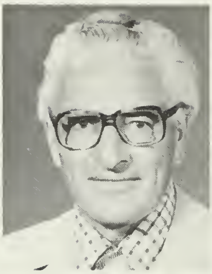
On a poursuivi nos activités internationales de développement et de recherches. La Direction générale a supporté, d'une façon très soutenue, les efforts de développement des marchés pour les produits agricoles canadiens. Les activités comprennent des échanges scientifiques et de coopération dans le cadre de protocoles d'entente et d'autres types d'accords avec la Yougoslavie, l'U.R.S.S., la Chine, la Roumanie, la Belgique, la France, Israël, l'Inde, le Pakistan, le Sri Lanka, le Japon, la Tanzanie, le Kenya, le Brésil, le Vénézuela, le Mexique et plusieurs autres pays, et favorisent ainse la mise en marché du Ministère. De plus, les agences internationales et les groupes de travail maintiennent l'utilisation de l'expertise scientifique et technique de la Direction générale dans le cadre de leurs programmes d'échanges.

La Direction générale a collaboré avec d'autres directions générales du Ministère dans des domaines comme la révision des politiques, la planification stratégique et les programmes de réglementation de la moisissure bleue du tabac, de la flétrissure bactérienne de la pomme de terre et des mycotoxines. Les activités des comités de développement d'Agriculture Canada ont permis la préparation des stratégies fédérales de développement agricole dans la plupart des provinces. Nos activités interministérielles ont conduit au développement de stratégies et de programmes nationaux en biotechnologie, avec le Conseil national de recherches du Canada; à des systèmes d'information sur les cultures avec Énergie, Mines et Ressources Canada et sur le climat, les pluies acides, les ressources des terres, les pesticides et les mycotoxines avec Environnement Canada et d'autres ministères concernés.

La Direction générale a complété la révision du budget 'A' en 1983. Le Ministère utilisera cette révision pour informer les agences centrales telles que le Conseil du Trésor, le Ministère d'État au développement économique et régional et le Ministère d'État à la science et la technologie au sujet des bénéfices économiques importants qui proviennent de nos programmes de recherches, pour illustrer la rentabilité des investissements dans ces programmes et pour démontrer les besoins de ressources additionnelles pour le développement de nouvelles technologies afin de supporter le secteur agro-alimentaire au cours de la prochaine décade.

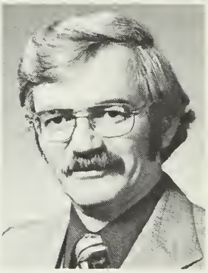
E.J. LeRoux

INSTITUTES DIRECTORATE
DIRECTION DES INSTITUTS



Dr. J. W. Morrison

Mrs. E. Larmond



Mr. D. G. Proctor

EXECUTIVE OF THE INSTITUTES DIRECTORATE
L'EXÉCUTIF DE LA DIRECTION DES INSTITUTS

Director General
Directeur général
J. W. Morrison, B.Sc., M.Sc., Ph.D.

Program Specialist
Spécialiste en programmes
E. Larmond, B.Sc.

Acting Chief, Administration
Chef intérimaire, administration
D. G. Proctor

PREFACE

The Institutes Directorate, located at the Central Experimental Farm in Ottawa, consists of the Biosystematics Research Institute (BRI), Chemistry and Biology Research Institute (CBRI), Engineering and Statistical Research Institute (ESRI), Food Research Institute (FRI), Land Resource Research Institute (LRRI), and Research Program Service (RPS). In 1983 the Institutes' programs were conducted by a staff of 586 with a budget of $37 million. All the institutes combine active research on national programs with service to regional stations or to the public in specialized areas of their research. Significant research accomplishments are highlighted in the reports of the individual establishments. Some examples of service to regional stations and to the public are mentioned here.

The instrumentation and analytical services of CBRI continued to provide support to Branch establishments. The combined operations of the Electron Microscope Centre, the Analytical Chemistry Services (ACS), and the Mineral Analysis Services catered to 192 requests for services from Branch establishments across Canada, other government agencies, and universities. Based on current commercial costs the ACS saved the Branch approximately $3 million for analyses performed.

Collaborative work by Statistical Research Service at ESRI continued to provide support to most commodity objectives with a wide impact on research. A statistical training course was presented at 14 Branch establishments. Engineering work in support of animal production and crop production progressed, including the development of a laparotomy operating cradle system, a sow milking system, a cattle grazing timer, an oviposition recording system for 1024 hens, a feed dispenser for sheep, a feed weight monitoring system for chickens, a leaf moisture meter, a cereal plot seeder, a low-cost light meter for growth chambers, a forage plot seeder, and a device for measuring plant volumes.

A total of 28 departmental and 92 Research Branch publications were released by RPS during the year. Of these, 11 were priced publications. Thirty-five bulletins were published in the Research Branch technical bulletin series, which provides timely technology transfer to specialized audiences. A total of 2124 jobs were handled by the Graphics Section for research establishments across Canada. The importation of insect parasites and predators continued, as a service to the Branch and to the Canadian Forestry Service of Environment Canada. In 1983, 22 shipments were received from 10 countries.

The Biosystematics Research Institute provides Agriculture Canada and other departments and agencies and their clients with a unique center of systematic expertise for dealing with economic and social problems relating to insects, mites, spiders, plant parasitic nematodes, weeds, crop plants, native plants, plant parasitic and biodegrading fungi, and nonmedical bacteria. As the only Canadian organization with comprehensive collections, systematic research, and identification expertise, BRI continues to provide all systematic services to support production and resource protection for two major Canadian industries, agriculture and forestry. Research activities have been progressively realigned in response to demands in areas such as integrated pest management, environmental protection, and biotechnology.

During 1983 concerns about soil degradation increased and LRRI assumed a more active role in planning and implementing conservation practices. LRRI staff members in the National Capital, Ontario, New Brunswick, Nova Scotia, Manitoba, and Alberta have been involved in the development of land resource planning for agricultural development programs in those provinces.

The sensory evaluation unit of FRI continued to provide significant support for the research programs of FRI, other Agriculture Canada centers, provincial agencies, and industrial laboratories. During 1983 sensory evaluation tests assessed such products as beef, eggs, pork, and turkey and helped in the study of the effect of such factors as processing, feed, breed, and age on quality. Workshops, seminars, and personal communication continued to increase the awareness of the value of sensory evaluation among scientists involved in food technology research. During the year, Dr. John Holme, Director of the Food Research Institute, left the Public Service to take up a position in private industry. Dr. Norman Tape was subsequently appointed Director of the Food Research Institute.

Further information about our programs may be obtained by writing to the research establishments concerned or by addressing inquiries to Institutes, Research Branch, Agriculture Canada, Room 2077, K. W. Neatby Building, Ottawa, Ont. K1A 0C6.

J. W. Morrison

PRÉFACE

La Direction générale des Instituts, dont le siège administratif est à la Ferme expérimentale centrale d'Ottawa, comprend l'Institut de recherches biosystématiques, l'Institut de recherches chimiques et biologiques, l'Institut de recherches techniques et de statistiques, l'Institut de recherches sur les aliments, l'Institut de recherches sur les terres, et le Service aux programmes de recherches. En 1983, les divers programmes des instituts ont occupé un personnel de 586 personnes et un budget de 37 millions de dollars leur a été affecté. Tous les instituts accomplissent à la fois des activités de recherches dans le cadre des programmes nationaux et offrent des services spécialisés aux stations régionales ou au public dans les divers domaines qui leur sont propres. Les rapports des différents établissements mettent en évidence plusieurs réalisations notoires et nous en mentionnerons ici quelques exemples.

Les Services analytiques et de l'appareillage de l'Institut de recherches chimiques et biologiques ont, comme par le passé, aidé les divers établissements de la Direction. Les activités d'ensemble du Centre de microscopie électronique, des Services de chimie analytique et des Services d'analyse minérale ont pu répondre à 192 demandes provenant de ces établissements partout au Canada et d'autres organismes publics et d'universités. En se basant sur les prix commerciaux courants, les Services de chimie analytique ont permis à la Direction d'économiser environ 3 millions de dollars sur les analyses effectuées.

Les travaux réalisés en collaboration avec le Service de recherches statistiques de l'I.R.T.S. ont continué de concourir à la plupart des objectifs intéressant l'agro-alimentaire et ayant des répercussions très variées sur la recherche. Un cours de statistique a été institué dans 14 des établissements de la Direction. Les travaux techniques qui concernent les productions animales et les récoltes ont produit de nouvelles améliorations, entre autres un berceau pour les opérations de laparotomie, un système de traite pour les truies, un compteur de durée de la paissance des bestiaux, un enregisteur de ponte pour 1 024 poules, un distributeur de provendes pour ovins, un dispositif de surveillance du poids des aliments pour les volailles, un appareil de mesure de l'humidité des feuilles, un semoir pour parcelles de céréales, un compteur d'éclairage de prix modique pour les chambres de croissance, un semoir pour parcelles de plantes fourragères et un dispositif mesureur du volume des plantes.

Au cours de l'année, le Service aux programmes de recherches a fait paraître 28 publications émises par le Ministère et 92 par la Direction de la recherche. Parmi ces publications 11 n'étaient pas gratuites. Trente-cinq bulletins ont paru dans la série des Bulletins techniques de la Direction générale de la recherche, dans le but de transmettre des informations techniques opportunes à une clientèle spécialisée. Au total, la section des Arts graphiques a effectué 2 124 travaux pour des établissements de recherches dans tout le Canada. L'importation de parasites et de prédateurs des insectes s'est poursuivie, à titre de service à la Direction générale de la recherche d'Agriculture Canada et au Service canadien des forêts d'Environnement Canada. En 1983, on a reçu 22 envois qui provenaient de 10 pays étrangers.

L'Institut de recherches biosystématiques constitue pour Agriculture Canada, pour d'autres ministères et organismes et pour leurs clients, un centre unique de connaissances spécialisées dans l'étude des problèmes économiques et sociaux reliés aux insectes, aux acariens, aux araignées, aux nématodes parasites des plantes, aux plantes adventices, aux plantes cultivées, aux végétaux indigènes, aux champignons parasites des plantes et biodégradants, et aux bactéries non médicales. Seul organisme canadien disposant de collections d'ensemble et possédant l'expérience technique de la systématique et de l'identification, l'I.R.B. a continué d'assurer tous les services pertinents nécessaires à la production et à la protection des ressources naturelles aux deux grandes industries canadiennes que sont l'agriculture et la forêt. Les activités de recherches ont été progressivement réorientées en fonction des exigences de certains secteurs telles que l'intégration des mesures de lutte contre les parasites, la protection de l'environnement et la biotechnologie.

On a constaté en 1983 une prise de conscience plus aiguë des dangers causés par la dégradation des sols, et de la nécessité d'un rôle plus actif de l'Institut de recherches sur les terres dans la planification et l'application des mesures de conservation. Le personnel de l'I.R.T. de la capitale nationale, celui de l'Ontario, du Nouveau-Brunswick, de la Nouvelle-Écosse, du Manitoba et de l'Alberta ont tous participé à l'élaboration de plans concernant l'application des ressources des sols au progrès de l'agriculture dans ces diverses provinces.

La sous-section d'évaluation sensorielle de l'Institut de recherches sur les aliments a poursuivi ses efforts en vue d'aider d'autres chercheurs de l'I.-R.A., de divers centres d'Agriculture Canada, d'organismes provinciaux et de laboratoires industriels. En 1983, les tests d'évaluation sensorielle ont mesuré des produits comme la viande de boeuf, de porc et de dinde, les oeufs, visant à vérifier les effets des procédés de transformation, de l'alimentation, de la race et de l'âge sur la qualité de ces produits. Des chercheurs en agro-alimentaire ont pu bénéficier d'une autre série d'ateliers, de conférences et de communiqués directs pour améliorer leur appréciation de l'évaluation sensorielle. Au cours de l'année écoulée, John Holme, directeur de l'Institut de recherches sur les aliments a quitté la Fonction publique pour occuper un emploi dans l'industrie privée. Norman Tape lui a succédé.

Les personnes intéressées peuvent obtenir de plus amples renseignements sur nos programmes en écrivant aux établissements de recherches concernés ou en s'adressant directement aux Instituts, Direction générale de la recherche, Agriculture Canada, Pièce 2077, Édifice K.W. Neatby, Ottawa, Ont., K1A 0C6.

J.W. Morrison

Biosystematics Research Institute

Ottawa, Ontario

PROFESSIONAL STAFF

G. A. Mulligan, B.Sc.	Director
I. M. Smith, B.Sc., Ph.D.	Assistant Director
E. Gavora,[1] I.N.G., B.L.S.	Librarian, Botany
P. J. Purcell-Smith,[1] B.A., M.L.S.	Librarian, Entomology
J. E. H. Martin	Manager, National Identification Service, Zoology; Unit Curator of Miscellaneous Insect Orders
P. M. LeClair	Manager, National Identification Service, Botany
A. Giroux	Administrative Officer

Nematode, Hymenoptera, and Hemiptera Section

R. V. Anderson, B.A., M.S., Ph.D.	Head of Section; Unit Curator of Nematodes; Hoplolaimidae (spiral nematodes), Tylenchorhynchidae (stylet nematodes), Aphelenchoidea (foliar nematodes)
J. R. Barron, B.Sc., M.Sc., Ph.D.	Ichneumonidae (ichneumon wasps)
B. A. Ebsary, B.Sc., M.Sc., Ph.D.	Criconematidae (ring nematodes), Hemicycliophoridae (sheath nematodes)
R. G. Foottit, B.S.A., M.Sc., Ph.D.	Aphids, scales, and thrips
G. A. P. Gibson, B.Sc., M.Sc.	Chalcidoidea (chalcid wasps)
H. Goulet, B.A., B.Sc., M.Sc., Ph.D.	Symphyta (sawflies)
K. G. A. Hamilton, B.S.A., M.Sc., Ph.D.	Unit Curator of Hemiptera; Cicadellidae (leafhoppers), Cercopidae (spittlebugs)
L. A. Kelton, B.S.A., M.Sc., Ph.D.	Miridae (plant bugs), Anthocoridae (flower bugs)
L. Masner, B.Sc., M.Sc., Ph.D.	Proctotrupoidea (proctotrupid wasps), Sphecoidea (digger wasps), Evanioidea (ensign wasps); Unit Curator of Hymenoptera
W. R. M. Mason, B.Sc., Ph.D.	Braconidae (braconid wasps)

M. J. Sharkey, B.Sc., M.Sc., Ph.D.	Braconidae (braconid wasps)
C. M. Yoshimoto,[2] B.A., M.Sc., Ph.D.	Chalcidoidea (chalcid wasps), Cynipoidea (gall wasps)

Arachnida, Diptera, and Insect Biology

C. D. Dondale, B.Sc., M.Sc., Ph.D.	Head of Section; Araneae (spiders), Opiliones (harvestmen)
V. M. Behan-Pelletier, B.Sc., M.Sc., Ph.D.	Oribatei (oribatid mites); Unit Curator of Arachnida
A. Borkent, B.Sc., M.Sc., Ph.D.	Cecidomyiidae (gall midges), Ceratopogonidae (biting midges)
E. E. Lindquist, B.Sc., M.Sc., Ph.D.	Acari (mites and ticks)
R. Matsuda, B.A., Ph.D., D.Sc.	Comparative morphology and evolution
J. F. McAlpine, B.S.A., M.Sc., Ph.D.	Lonchaeidae (lance flies), Chamaemyiidae (silver flies)
D. R. Oliver, B.A., M.A., Ph.D.	Chironomidae (chironomid midges)
I. M. Smith, B.Sc., Ph.D.	Eriophyoidea (rust and gall mites), Hydrachnida (water mites)
H. J. Teskey, B.Sc., M.S.A., Ph.D.	Tabanidae (horse flies and deer flies)
J. R. Vockeroth, B.A., M.A., D.Phil.	Syrphidae (flower flies), Scatophagidae (dung flies)
D. M. Wood, B.A., M.A., Ph.D.	Tachinidae (parasitic flies), Culicidae (mosquitoes)

Coleoptera, Lepidoptera, and Trichoptera

J. D. Lafontaine, B.A., M.S., Ph.D.	Head of Section; Noctuidae (cutworm moths); Unit Curator of Lepidoptera-Trichoptera
S. A. Allyson, B.Sc., M.Sc.	Lepidopterous larvae (caterpillars)
Y. Bousquet, B.Sc., M.Sc.	Colydiidae, Elateridae (click beetles and wire worms, and other stored-products beetles)
D. E. Bright, B.Sc., M.Sc., Ph.D.	Scolytidae (bark beetles), Curculionidae (weevils)
J. M. Campbell, B.Sc., M.S., Ph.D.	Staphylinidae (rove beetles)
P. T. Dang,[2] B.Sc., M.S., Ph.D.	Microlepidoptera of forest importance (spruce budworm)
J. F. Landry, M.Sc.	Mirolepidoptera of agricultural importance
L. LeSage, B.Sc., M.Sc., Ph.D.	Chrysomelidae (leaf beetles)
A. Mutuura, B.Sc., Ph.D.	Tortricidae (leafroller moths)
F. Schmid, Lic. ès Sc. Nat., D. ès Sc. Nat.	Trichoptera (caddisflies)
A. Smetana, M.U.DR., Cand. Sc. Biol.	Aquatic beetles, Staphylinidae (rove beetles); Unit Curator of Coleoptera

Mycology: Plant Disease and Biodegrading Fungi

G. A. Neish, B.Sc., Ph.D.	Head of Section; Mycotoxin fungi
D. J. S. Barr, B.Sc., M.Sc., Ph.D.	Zoosporic parasites of vegetable crops; Curator of National Collection of Fungus Cultures
J. D. Bissett, B.Sc., Ph.D.	Conidial parasites of forage crops
M. P. Corlett, B.A., M.A., Ph.D.	Ascocarpic parasites of fruit crops
Y. Dalpé, B.Sc., M.Sc., D.Sc.	Mycorrhizae
J. H. Ginns, B.Sc., M.Sc., Ph.D.	Basidiocarpic tree wood rots
J. A. Parmelee, B.Sc., M.A., Ph.D.	Obligate parasites of plants (rusts, smuts, mildews); Curator of National Mycological Herbarium
S. A. Redhead, B.Sc., M.Sc., Ph.D.	Mushrooms
R. A. Shoemaker, B.S.A., M.S.A., Ph.D.	Ascocarpic parasites of cereals

Vascular Plants

B. R. Baum, M.Sc., Ph.D.	Head of Section; Cultivated crops, *Hordeum*
S. G. Aiken, B.Sc., M.Sc., Ph.D.	Grass flora of Canada
G. Baillargeon, B.S.A., M.Sc.	Cultivated crops, *Brassica*
I. J. Bassett, B.A.	Hay-fever plants, palynology, weeds
P. M. Catling, B.Sc., Ph.D.	Sedges, aquatic plants
C. W. Crompton, M.Sc.	Weed biology—Taxonomy and palynology
W. J. Cody, B.A.	Curator of Herbarium; Canadian flora, ferns
G. A. Mulligan, B.Sc.	Weeds, Cruciferae
E. Small, B.A., B.Sc., M.Sc., Ph.D.	Cultivated crops, *Medicago*
A. E. Stahevitch, B.Sc., M.Sc., Ph.D.	Weeds, cytotaxonomy
S. I. Warwick, B.Sc., Ph.D.	Weeds, genecology

Honorary Research Associates

J. W. Arnold, B.A., M.Sc., Ph.D.	Insect hemocytology (blood cells)
E. C. Becker, B.Sc., M.Sc., Ph.D.	Elateridae (click beetles, wireworms)
J. A. Downes, B.Sc.	Ceratopogonidae (biting midges)
G. P. Holland, B.A., M.A., D.Sc., F.R.S.C.	Siphonaptera (fleas)
S. J. Hughes, B.Sc., M.Sc., D.Sc., F.L.S., F.R.S.C.	Conidial molds of wood and insects
W. C. McGuffin, B.A., M.A., Ph.D.	Geometridae (geometer moths, loopers)
D. B. O. Savile, B.S.A., M.Sc., Ph.D., D.Sc., F.R.S.C	Plant rusts
G. E. Shewell, B.Sc., M.Sc.	Lauxaniidae (lauxaniid flies), Calliphoridae (blow flies)

Departures

S. J. Hughes, B.Sc., M.Sc., D.Sc., F.L.S., F.R.S.C. Retired	Conidial molds of wood and insects
R. A. Sharrett, B.A., M.L.S.	Librarian, Entomology

---

[1] Seconded from Libraries Division, Finance and Administration Branch.
[2] Seconded from Environment Canada.

INTRODUCTION

The Biosystematics Research Institute (BRI) provides Agriculture Canada, other departments and agencies, and their clients with a unique center of systematic expertise for dealing with economic and social problems relating to insects, mites, spiders, plant parasitic nematodes, weeds, crop plants, native plants, plant parasitic and biodegrading fungi, and nonmedical bacteria. It provides Canadians with an expert team of scientists and technicians that maintains and updates an information system ensuring that the identities of any of these organisms can be determined accurately and that appropriate data on their biology and impact are quickly available. It is a vehicle for the flow of biosystematic information nationally and between Canada and other countries. The following broad aims guide the Biosystematics Research Institute in its operations: to conduct research to discriminate and correctly name organisms that occur in Canada or are otherwise of importance to Canadians; to contribute to science and its uses by developing natural classifications and interpreting evolutionary relationships; to develop and maintain the National Collections of living or preserved organisms from Canada and elsewhere to provide a reference base for biosystematic research on diversity and distribution, and for identification purposes; to provide a national identification service for clients, publish guides to help others make identifications, and supply relevant information; to provide inventories and floristic and faunistic studies for selected regions, habitats, or host groups to permit effective assessment and monitoring of environments, their quality, and their changes; to provide leadership and cooperation in the development of biosystematics in Canada by making expertise available for training and other educational purposes.

Reprints of publications are available from the authors. Correspondence on other matters should be addressed to the Director, Biosystematics Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

G. A. Mulligan
Director

COLLECTION DEVELOPMENT AND MAINTENANCE

The holdings of the Canadian National Collection of Insects, Arachnids, and Nematodes increased by some 475 000 specimens during 1983 and the classified holdings increased by 211 500 specimens. Major contributions were made by members of the Institute collecting throughout Canada, the western United States, Mexico, Ecuador, and Finland. During the summer of 1983, the Institute carried out a 5-mo survey of the arthropods of Cape Breton Highlands National Park, Nova Scotia, with 16 officers of the Institute participating. This is part of a 2-yr project that will continue until March 1985 and will provide a large collection of specimens pertinent to the research interests of the Institute to enhance the National Collection. Purchase of material amounted to 41 160 specimens and consisted of material from North and South America and Australia. Growth of the Collection mainly involved acquisition and curation of material required for current research activities of Institute scientists, but new acquisitions also increased representation of other groups of importance to Canadians. Requests for loaning of material from other scientists throughout the world amounted to 206 loans of some 100 000 specimens. Many scientists and students from various parts of the world continue to visit the Canadian National Collection to study and curate specific groups. The CanaColl Foundation grants supported seven people, who curated several thousand specimens of Trichoptera, Diptera, Hymenoptera, Lepidoptera, and Coleoptera. Maintenance of the zoology collections was carried out with the assistance of 14 persons employed under the new employment expansion development (NEED) program. This program was of great benefit to BRI, allowing for the development and maintenance of segments that would otherwise not have been possible with our present staff.

The holdings of the Vascular Plant Herbarium now stand at 750 521 collections, an increase of 17 992 during 1983. Some 2500 collections were made by staff members during field trips to the Yukon Territory, throughout most of the Canadian provinces, and in the northern and southeastern United States. A total of 5931 collections were donated to the herbarium, 861 as gifts and 5070 as exchange from other herbaria. This year 5600 vascular plant specimens were sent out on loan to 27 herbaria throughout the world. During the year, scientists from various herbaria in Canada, the United States, and France visited the collection to study specific groups of plants.

The holdings of the National Mycological Herbarium stand at 242 510 specimens, an increase of 3279 accessions during 1983. A total of 1887 specimens were donated, 513 as exchange from other herbaria and 1374 as gifts. A total of 2100 collections were made during field trips by staff members in Ontario, Quebec, Newfoundland, the northern United States, and Japan.

The National Collection of Fungus Cultures has increased its holdings from 7651 to 8005. This increase of 354 cultures was due mainly to material received through the Identification Service, cultures received for deposit from other establishments, or isolations made by staff members. At present, 2615 cultures have been successfully lyophilized for long-term preservation. This year 363 cultures were sent out in answer to requests from scientists in Canada and throughout the world.

Culture work with bacteria was postponed because of a staffing freeze.

NATIONAL IDENTIFICATION SERVICE

A total of 1122 shipments of insects, arachnids, and nematodes were received for identification during 1983 and some 64 000 specimens were identified. The primary users of this service were Environment Canada (19%), Canadian universities (16%), and Agriculture Canada (14%). Law enforcement and other investigating agencies were assisted by providing species identification and information on crimes and accidents. The development of larvae removed from a body was used in a murder case. Identification mostly involved crop and produce pests, pheromone studies, studies of foods utilized by ducks, fish, and other wildlife, biting and sucking flies, ticks, fleas, lice, mites, and spiders, vectors of diseases, and predators and parasites important in biocontrol and integrated pest management.

During 1983, 8829 collections of vascular plants were identified. Major users of the service this year were the general public (28%), Canadian and American universities (19% and 18%, respectively), and provincial government departments (12%). An increased number of inquiries was received directly from the general public and through Communications Branch, Agriculture Canada. Assistance was provided on the identification of weeds, edible plants, poisonous plants, and native plants. These identifications related to weed control research, to the identification of host plants of various insect pests and pathogens, to poisonings of humans and livestock, to aquatic weed problems, to studies investigating habitats of the Canada goose and other waterfowl, to the use of plant material in provincial and federal park interpretation programs, to plants collected as part of biophysical inventories for proposed park areas, and to studies on whether or not plant material can be safely imported or exported. During 1983, several inquiries were received from various police forces requesting assistance in the identification of plant material as possible evidence in criminal cases.

A total of 1941 collections and cultures of fungi were identified during 1983. Principal users of the service were the general public (34%), Agriculture Canada (26%), Canadian universities (12%), and Environment Canada (10%). Assistance was provided on the identification of plant pathogens, edible fungi, poisonous fungi, fungi used as biocontrol agents, and hallucinogenic fungi. Several staff members also provided assistance to the Agriculture Canada research station at Beaverlodge, Alberta, in the screening of leafcutting bee cocoons for the presence of chalkbrood. Research stations also received assistance involving postharvest diseases in fruit (British Columbia), storage problems related to cabbage and diseases of ornamental trees (Quebec), contaminated sheep feed causing suspected health problems (Prince Edward Island), and disease-resistance screening in potato breeding (New Brunswick). The majority of inquiries from the public were for the identification of edible mushrooms and from hospitals for mushrooms suspected of poisonings.

RESEARCH AND TECHNOLOGY TRANSFER

Nematoda, Hymenoptera, and Hemiptera

Research published or in press includes descriptions of eight new species of plant, terrestrial, and freshwater nematodes. Identity of a new ring nematode was made possible by experimentally validating the diagnostic value of a character that permits separation of closely related species. A published description of a new species of mycophagus nematode from beet-amended compost identifies a potential pest of mushroom production. Numbers of mushroom nematodes were found to reach levels of over a half a million per kilogram of compost. Most prevalent of the species groups were the bacterial-feeding rhabditids, comprising eight species. They accounted for 56–96% of any given sample.

Cooperative work on nematodes with the Vineland Station continued, with emphasis on virus vectors of nematodes. Studies of a species complex of dagger nematode vectors were successful in resolving the kinds occurring in Canada and in determining the identity of those currently used in transmission tests in Vineland. Of the four recognized species of the *Xiphinema americanum* group, one proved to be undescribed and offers potential for the further study of transmission. New cooperative research has been initiated at the research station at Vineland on the identity of problem species of stunt nematodes in Canada and at Saint-Jean-sur-Richelieu on entomophagous nematodes important in ongoing biocontrol studies.

Research emphasis in Hemiptera was on the systematics of leafhoppers and plant bugs, and on host associations and distribution in Canada. Application of statistical and morphometric analyses of six problem species of leafhoppers common on plants resulted in the discovery of 13 previously unknown species, including several potential pests. In progress is the first part of a major handbook on the leafhoppers in Canada and Alaska. Also in preparation is a definitive handbook on the plant bugs (Miridae) in British Columbia and the Yukon. This covers 45 genera and 150 species.

From survey results, several newly introduced European leafhoppers were discovered in Nova Scotia and Prince Edward Island, including one that is becoming a major pest in Halifax. Faunistic studies of the leafhoppers in Cape Breton Highlands National Park record 92 species and new occurrences for Canada, including several undescribed species. In preparation is a card catalog comprising 6000 species of leafhoppers described since 1955.

Continuing studies of the world spittlebugs using new character states further revealed the evolutionary and natural relationships of family members. In a published study of the pine aphids of British Columbia, three new subspecies of the balsam woolly aphid were named, new records of occurrence in Canada were given for five species, and 157 new hosts were identified.

Advances in the systematics of New World braconid wasps and *Dolerus* sawflies, using phylogenetic principles, have resulted in significant redefinitions of taxa. Concurrent with this work, a new classification scheme was proposed for the Order Hymenoptera at the superfamily level. This is based on phylogenetic analyses of existing and new characters, and alters concepts in homologies. A major contribution relating to this work was the discovery of a unique segmental articulation mechanism on the abdomen of *Pelicinus polyturator*. Invitational papers on the nomenclature and phylogeny of parasitic wasps were given at the 1983 annual meetings of the Entomological Society of America in Detroit. In a revisionary study of ichneumonid (*Rhorus*) parasites of sawflies, analyses of new characters led to 16 new integrated parasite–host associations and new information on their relationships. One scientist has contributed a chapter to a textbook on the evolution of Insecta. It synthesizes scattered evidence and proposes reconstructions of fossil Arthropoda.

Research on parasitic wasps covered a broad range of taxa, of which many have potential as biocontrol agents. Nearing completion is a major treatment on scelionid and platygasterid wasps. This work will include keys to genera, diagnoses for 42 genera, a glossary of terms, analysis of characters, and their world distribution. Also nearing completion is a monograph on the Mymaridae of the New World, in which 20 genera are new to science. In a revision of the New World species of sawflies of the genus *Dolerus*, 20 of 73 species are described for the first time.

Arachnida and Diptera

Revisions were completed and published on two large genera of mites, the Arctic soil-inhabiting group *Ceratozetes* (four new species) and the plant-feeding group *Trisetacus*. Descriptions of new species in 10 other mite genera also were published or submitted for publication. Eighteen species of wolf spiders comprising the North and Central American *Pardosa milvina* group, many of which prey on crop pests of alfalfa or cotton, were revised.

The phylogeny and classification of the world Tarsonemidae were investigated in a long-term study and a manuscript is in an advanced stage of preparation. A series of lectures arising from this work was given at the National University of Mexico. Research on the phylogeny and life history of arrenuroid and water mites, based largely on study of the parasitic larval instar, led to new proposals on their classification. Two invitational chapters on anatomy and phylogeny of plant-feeding mites were prepared for a two-volume work on biology and control of these pests. Investigation of the bodies of female mites associated with certain halictid bees led to the discovery of sporothecae. This explains the prior finding of many dead, spore-covered larvae in the ground nests of these bees, which are important pollinators of legumes. Lectures were presented on the role of soil mites in litter breakdown.

Many interesting range extensions of arachnid species have been noted in Cape Breton Highlands National Park, particularly among Appalachian groups. A survey of water mites and Eriophyoidea in coastal British Columbia, Oregon, and Washington revealed several undescribed species whose nearest living relatives are found in temperate regions of Asia and which appear to represent an ancient, relict fauna. An annotated list of British Columbia spiders was prepared in collaboration with workers in that province.

The 33 Holarctic genera of the subfamilies Diamesinae and Orthocladiinae (family Chironomidae) were defined and diagnosed as part of an international project under the leadership of Dr. T. Wiederholm of Sweden. Larval treatments appeared in print in 1983 as Part 1 of a three-part series. Pupal and adult treatments are in press. Further work on the midges, many of which are important indicators of water quality, was done in the group related to *Stenochironomus*. Sixty-five species, of which 17 are new to science, were analyzed cladistically, and the larvae, pupae, and both sexes of adults were found to conform to a single classification. Evidence for monophyly of the genus was put forward, and an analysis of ecological data was made showing how certain species have secondarily become feeders on submerged wood or leaves.

Coleoptera, Lepidoptera, and Trichoptera

The following papers on beetles were published or are in press: one describing a new genus and species of comb-clawed bark beetle from Florida and presenting a key to the genera occurring in North America; a paper describing the larva and pupa of one of the pill beetles, including a key to known Nearctic genera of byrrhid larvae; four short papers on the taxonomy of ground beetles; a paper proposing a nomenclature of primary setae and pores on larvae of these insects and a major taxonomic monograph of the genera of Elaphrini and species of *Elaphrus*, including phylogenetic and zoogeographical considerations; two papers on the immature stages of leaf beetles, one dealing with all immature stages of a cryptocephaline genus *Lexiphanes* and the other on Canadian species of *Neochlamisus* in the subfamily Chlamisinae; one paper on the geographical distribution of the water scavenger beetle genus *Hydrochara*; and another on the taxonomy and faunistics of the subfamily Sphaeridiinae. The first volume on the weevils of Canada and handbooks on metallic wood borers and hister beetles will soon be submitted for publication.

Staphylinidae (rove beetles): One paper dealing with the taxonomy and geographical distribution of the genus *Derops* was published and another four papers, dealing with the genera *Gabrius* and *Thinobius* and the tribe Megarthropsini, were accepted for publication. Two papers revising the genera *Olophrum* and *Pycnoglypta* were published. Three additional papers were accepted for publication: reporting the first North American record of the European species *Anotylus insecatus*; revising the genera *Arpedium* and *Eucnecosum*; and revising the genera *Orochares* and *Porrhodites*. A large memoir revising the genus *Aleochara*, which contains parasites of economically important flies, was accepted for publication.

Scolytidae (bark beetles): The bibliography portion of the catalog of the Scolytidae and Platypodidae of the world is about half completed. This represents some 2000–3000 references dating from 1960 to present. Completion of the bibliography is the first goal of this project and it is hoped that this will be achieved next year.

A preliminary draft of a large manuscript dealing with the distribution, damage, and life history of all Canadian Coleoptera known to be pests of agriculture and food products was completed and distributed for external review. Substantial progress was made on the identification guide to the stored products and household beetle pests in Canada.

The following works on butterflies, moths, and caddisflies were published or are in progress: a manuscript on the larvae of the tribe Spilomelini and a study of the biology and taxonomy of the Crambinae leafrollers; a manuscript on the larvae of the genus *Zeiraphera* of North America; a paper on the budworm species of *Proteoteras*, pests of Manitoba maple from the Canadian prairies; a manuscript on host associations and taxonomy of pine seed worms in the genus *Cydia*; and a paper on a new species of *Cochylis*, a pest of sunflower from Saskatchewan. Two new projects were initiated, on the caddisfly genera *Setodes* and *Leptocerus* and on a revision of the Pseudostenophylicinae of the world. A paper on the taxonomy, phylogeny, and zoogeography of a group of arctic cutworms (*Xestia* subgenus *Schoyenia*) that occur in Canada and the USSR and a checklist of the butterflies of the Yukon Territory were published.

Fungi

A wood-decaying mushroom, *Callistosporium luteo-olivaceum* (Berk. & Curt.) Singer originally described from tropical America, was shown to have been described under 11 different species names and to occur in southern Canada. *Stereopsis humphreyi* (Burt) Redhead & Reid, a west coast endemic, was shown to have been misunderstood and misplaced in the genus *Craterellus*. A global revision of leptoglossoid agarics, a primarily arctic-alpine group, culminated in radical revision of the two genera *Arrhenia* (five new combinations) and *Rimbachia* (seven new combinations, one new Canadian species), two new tropical genera, three new combinations in other genera, and one other new species. Studies of North American species of the genus *Hericium* (wood rot fungi) have emphasized the need for distinguishing the species in culture and consequently on the use of genetic markers (i.e., mating type alleles) to confirm or deny the conspecificity of morphologically similar individuals.

Four full-cycled species of *Puccinia* on Ranunculaceae were described and illustrated to complete a treatment of 11 rust species parasitizing this plant family in Canada.

The ascomycete *Venturia asperata* Samuels & Sivanesan, which causes a leafspot disease of apple in New Zealand, was found in Canada for the first time on ornamental crab apple. The genus *Leptosphaeria* has been revised, and some allied genera were segregated on the basis of morphological differences and on host plant specialization. *Lophophacidium dooksii* Corlett & Shoemaker, a new needle cast fungus of white pine, was described. Thirteen species of the coelomycete genus *Phyllosticta* were described, completing a study on all species of this genus of leafspot fungi occurring in Canada. The hyphomycete species *Janetia mangiferae* Hughes & Cavalcanti and *Janetia capnophila* Hughes, and the genus *Johncouchia* Hughes & Cavalcanti, were described as new. Monographic work on the hyphomycete genus *Trichoderma* continued. Ten new species were described, mostly from Canadian collections.

The pleomorphy of some foliicolous parasites, with hyphodiate hyphae, was established. A *Questieriella* (new genus) synanamorph was shown to occur in both species of *Mitteriella* and most species of *Sarcinella*. The *Sarcinella* and *Questieriella* combination of synanamorphs was shown to be correlated with the ascomycete *Schiffnerula*. A new species of *Aspergillus* isolated from forest soils in Quebec was described.

Collections of fungi belonging to the endogonaceous genus *Sclerocystis* were added to the collection and tested for their mycorrhizal capacities. This genus is now known to occur commonly in Eastern Canada. Experimental work on the colonization in a growth chamber of *Tagetes* and *Asparagus* seedlings by different *Glomus* and *Gigaspora* species resulted in the production of endomycorrhized roots. Further progress was made in the study of the fungi associated with ericoid mycorrhizae. Zoospores of 38 isolates of *Spizellomyces* were critically compared in the transmission electron microscope and the results were used to support species concepts.

The *Compendium of Plant Disease Fungi in Canada*, an up-to-date reference book for plant pathologists, ecologists, plant breeders, and mycologists, a manuscript of more than 1700 pages, is at present undergoing final revision and editing.

In 1980, vascular plants in Waterton Lakes National Park, Alberta, were surveyed for obligate parasitic fungi. The survey results were completed in 1983 and the ensuing report includes 117 fungus species, over half of which are rusts. Twelve new records for the park, for the province, or for Canada are indicated and a host index aids identification of the parasites.

An investigation on the incidence and epidemiology of the fungus disease histoplasmosis in Canada concluded that the fungus causing the disease is endemic in southern Ontario and Quebec.

The mycotoxin deoxynivalenol (vomitoxin) is produced by the head blight fungus *Gibberella zeae* (Schw.) Petch. The importance of this toxin as a contaminant of Canadian wheat was reevaluated in the light of new Health Protection Branch guideline levels and new data on the occurrence of the toxin in Canadian wheat. The conclusions were presented at an international meeting of fusarium workers.

Significant progress has been made toward elucidating the life cycle of *Polymyxa graminis* Ledingham, the vector of several destructive virus diseases of economically important crops. Detailed studies of fruiting bodies and cultures enabled the occurrence and ecological role of *Daedalea extensa* Peck to be revised and clarified.

Twenty Canadian species were illustrated and fully described for *Fungi Canadenses*. These included four grass and cereal *Septoria* parasites, three of which cause speckled leaf blotches of wheat or barley; twelve wood-degrading hyphomycetes in the genera *Helminthosporium*, *Cordana*, and *Bactrodesmium*; *Puccinia striiformis* Westend., causal agent of stripe rust of wheat; *Venturia saliciperda* Nüesch, the cause of leaf scab and shoot die-back of willows; and two conspicuous fleshy fungi new to Canada in the genera *Peziza* and *Sowerbyella*.

Vascular plants

Electrophoretic studies on triazine-resistant and susceptible populations of redroot pigweed indicated reduced variability in resistant compared with susceptible populations. Among the susceptible populations, variability within populations decreased from south to north along a 800-km transect in Ontario.

Many target species for biological control are members of the family Compositae (Asteraceae). Consequently, an enumeration of composites for host-specificity tests was prepared, using the criteria of economic and environmental importance. Studies continued on species of sagebrushes and wormwoods (*Artemisia*) important in crop and rangeland management. Field surveys were carried out in the Prairie Provinces. Studies of aberrant microsporogenesis were carried out on lemonwood, *A. abrotanum* L., and common wormwood, *A. vulgaris* L.

Field surveys of leaf spurges (*Euphorbia*) were completed and a nursery was established. Palynological, morphological, cytological, and breeding studies were carried out. An illustrated summary of biotypes was prepared for the Commonwealth Institute of Biological Control. Cytological, palynological, and taxonomic studies are being carried out on New World *Stachys*.

A paper was prepared on aberrant microsporogensis in *Impatiens* L., a source of bedding and greenhouse ornamentals. Of 26 taxa examined, 17 exhibited abnormal meiosis. Pollen stainability was reduced. The possible role of hybridization in the formation of the affected taxa was discussed.

Taxonomic problems in the genus *Festuca* have been considered and a manuscript on the restricted taxonomic value of leaf sections in Canadian narrow-leaved *Festuca* has been produced. Field trips to collect living material of disjunct populations of rough fescues in Michigan and on Mount Albert, Gaspé Bay, were undertaken and these plants are being grown beside plants of rough fescue collected earlier from western provinces.

A Departmental monograph, *Grass genera of Western Canadian cattle rangelands*, was published in 1983. It is intended to assist students, technicians, research scientists, and agricultural workers in identifying the 64 genera of grasses found in cattle rangelands.

Using the world grass genera data bank, produced in Australia, data have been checked and Canadian information has been added to produce a Canadian grass genera data bank, using a free-format data-inputting system. The system relates to two parallel character lists, one in English and the other in French. Qualifying taxonomic comments in the data bank were initially only in English, but they have been translated into French and inserted. Keys to 109 genera of grasses in Canada have been produced in both French and English, as have preliminary descriptions to the genera. The flexibility of the system has been demonstrated by producing a key to the genera in Quebec in French, and a key to the Yukon in English. Similar keys to each of the provinces and the territories could easily be produced.

Work is under way to revise and extensively rewrite an earlier Agriculture Canada bulletin on wild rice. As a preliminary to understanding taxonomic problems in the genus, a small wild rice paddy was built at the Central Experimental Farm in 1983 and wild rice specimens from different areas were grown side-by-side.

Taxonomic clarification of the alfalfa genus *Medicago* continued toward the goal of producing a monograph. To date, about 100 plates of illustrations have been completed. Taxonomic papers were prepared on *Medicago*, section Intertextae, and on the *M. blancheana-rotata* complex, and progress was made toward papers on the *M. sativa* complex and the *M. murex* complex. A study of pollen characteristics of the various kinds of wild and cultivated alfalfas was accepted for publication. A study of the relationship of pod coiling in alfalfa and resistance against the seed chalcid produced information of some economic interest.

A review of the evolutionary role of hybridization in crop plants was presented to the Montreal meeting of the International Organization of Plant Biosystematists and will appear in a symposium volume. A contract with Acadia University to produce a monograph on the genus *Vaccinium* in North America has resulted in a 300-page manuscript, providing an economic conspectus of all North American species of blueberries and cranberries. Two papers concerning section Paludosae of the sedge genus *Carex* were completed, one concerning the identity and status of hybrids, the other concerning sectional realignments.

A numerical taxonomic analysis of the *Hordeum murinum* and *H. geniculatum* groups of barley was carried out; and a numerical taxonomic investigation of the infraspecific variability of *H. bulbosum* was initiated. Work continued on a worldwide taxonomic revision of the barley genus *Hordeum*.

Variation studies in populations of Johnson grass in Ontario provided evidence for two types of Johnson grass. One is a later-flowering, overwintering population plant that characteristically produces large amounts of rhizome and small dormant seeds. The other type does not overwinter and produces smaller amounts of rhizome and larger nondormant seeds.

For the series *Biology of Canadian Weeds*, an article was completed on curly-leaved pondweed (*Potamogeton crispus* L.). Papers were published reviewing the biology of two new problem-weed species in Canada, hairy galinsoga and Johnson grass. In the process of completing an account on Russian thistle, *Salsola pestifer* A. Nels., the closely related species *Salsola collina* Pall. was discovered from Saskatchewan and Ontario. This introduced weedy species from Eurasia has not previously been reported for Canada. Accounts of three closely related annual species of nightshades, *Solanum ptycanthum* Dun., *S. nigrum* L., and *S. sarachoides* Sendt., are nearing completion. *Solanum americanum* Mill., a name once applied to *S. ptycanthum*, is actually very rare in Canada. An account on St. John's-wort (*Hypericum perforatum*) is being prepared in cooperation with Kentville Research Station.

The final version of the *Barley Register* will be submitted for publication in 1984. This will include pedigrees, coefficients of parentage, synonyms, and other data. The number of cultivar names in the final version is about 8000. A catalog of the accessions of the Canadian–Scandinavian germ plasm bank of wild and cultivated *Hordeum* has been submitted for publication. Each accession includes chromosome numbers and other data.

A manuscript entitled *Inventory of Canadian Weeds of Agricultural Importance* is being prepared, covering all weeds known to have agricultural significance. The treatment covers 600 species and deals with their nomenclature, distribution, and frequency, and the crops affected. A bibliography is included.

A paper was completed concerning the distribution and ecology of the bladderworts (*Utricularia*) in Ontario. The inventory of Canadian aquatic plants was continued with the preparation of a distribution chart and identification keys. An article was prepared concerning the identification of water milfoils in the Ottawa District and Ottawa River. An inventory of Catarqui Marsh was continued with the preparation of a final 50-page report for Parks Canada, including vegetation description, annotated checklist, and phytogeography. An introductory update to the reprint of the *Plants of Prince Edward Island* was completed. Earlier work on the vegetation of Sable Island, Nova Scotia, was expanded. A large manuscript on the flora of Riding Mountain National Park has been accepted for publication as a bulletin. This manual, in which about half of the 669 species treated are illustrated, will be of considerable interest to Park planners as well as to the visiting public. It will also be a useful tool for agriculturists in the surrounding region.

PUBLICATIONS

Research

Aiken, S.; Darbyshire, S. 1983. Grass genera of Western Canadian cattle rangelands. Agric. Can. Monogr. No. 29. 173 pp.

Anderson, R. V. 1983. Description of *Distolabrellus veechi* n. gen., n. sp. (Nematoda: Rhabditidae). J. Nematol. 15:70-75.

Anderson, R. V. 1983. Morphological characteristics of *Hoplolaimus inducus* Sher, 1963 in Canada, a parasite of wild rice. J. Nematol. 15:366-369.

Arnold, J. W.; Hinks, C. F. 1983. Haemopoiesis in Lepidoptera. III. A note on the multiplication of spherule cells and granular haemocytes. Can. J. Zool. 61:275-277.

Barr, D. J. S.; Allan, P. M. E. 1982. Zoospore ultrastructure of *Polymyxa graminis* (Plasmodiophoromycetes). Can. J. Bot. 60:2496-2504.

Bassett, I. J.; Crompton, C. W. 1982. The biology of Canadian weeds. 55. *Ambrosia trifida* L. Can. J. Plant Sci. 62:1003-1010.

Bassett, I. J.; Crompton, C. W.; McNeill, J.; Taschereau, P. M. 1983. The genus *Atriplex* (Chenopodiaceae) in Canada. Agric. Can. Monogr. 31. 72 pp.

Baum, B. R. 1983. Morphometric relationships in *Hordeum vulgare* (Triticeae, Poaceae). II. *Hordeum agriocrithon, H. distichum, H. lagunculiforme, H. spontaneum,* and *H. vulgare.* Can. J. Bot. 61:2023-2031.

Baum, B. R. 1983. Relationships between transformation series and some numerical cladistic methods at the infraspecific level, when genalogies are known. *In* Felsenstein, J., editor. Numerical taxonomy NATO-ASI Series GI:340-345. Springer Veilag, Berlin.

Baum, B. R. 1983. A phylogenetic analysis of the tribe Triticeae (Poaceae) based on morphological characters of the genera. Can. J. Bot. 61:518-535.

Baum, B. R.; Bailey, L. G. 1983. Morphometric relationships in *Hordeum vulgare* (Triticeae, Poaceae). I. *H. spontaneum.* Can. J. Bot. 61:2015-2022.

Becker, E. C. 1982. The European *Tribolium madens* (Charpentier) in North America (Tenebrionidae). Coleopt. Bull. 36:166-169.

Behan-Pelletier, V. M.; Hill, S. B. 1983. Feeding habits of sixteen species of Oribatei (Acari) from an acid peat bog, Glenamoy, Ireland. Rev. Ecol. Biol. Sol 20:221-267.

Behan-Pelletier, V. M.; Norton, R. A. 1983. *Epidamaeus* (Acari: Damaeidae) of Arctic western North America and extreme northeast, U.S.S.R. Can. Entomol. 115:1253-1289.

Bissett, J. D. 1982. *Pestalotiopsis menezesiana* on greenhouse plantings of *Cissus rhombifolia* with notes on related fungi occurring on Vitaceae. Can. J. Bot. 60:2570-2574.

Bissett, J. D. 1983. Notes on *Tolypocladium* and related genera. Can. J. Bot. 61:1311-1329.

Bright, D. E. 1982. Scolytidae (Coleoptera) from the Cocos Islands, Costa Rica, with description of one new species. Coleopt. Bull. 36:127-130.

Campbell, J. M. 1982. A new species of *Hymenorus* (Coleoptera: Alleculidae) from California. Coleopt. Bull. 36:131-134.

Campbell, J. M. 1983. A revision of the North American Omaliinae (Coleoptera: Staphylinidae). Can. Entomol. 115:577-622.

Campbell, J. M. 1983. A new species of *Pycnoglypta* Thomson (Coleoptera: Staphylinidae) from Eastern Canada. Can. Entomol. 115:361-370.

Catling, P. M. 1982. Breeding systems of northeastern North American *Spiranthes* (Orchidaceae). Can. J. Bot. 60:3017-3039.

Catling, P. M. 1983. *Spiranthes ovalis* var. *erostellata* (Orchidaceae), a new autogamous variety from the eastern U.S. Brittonia 35:120-125.

Catling, P. M. 1983. *Spiranthes ochroleuca* (Rydberg ex Britton) Rydberg (Yellow Ladies'-tresses Orchid) verified in North Carolina. Castanea 48:48-49.

Catling, P. M. 1983. Autogamy in Eastern Canadian Orchidaceae: A review of current knowledge and some new observations. Nat. Can. 110:37-53.

Catling, P. M. 1983. Pollination of northeastern North American *Spiranthes* (Orchidaceae). Can. J. Bot. 61:1080-1093.

Catling, P. M.; Dore, W. G. 1982. Status and identification of Hydrocharis morsus-ranae and limnobium spongia (Hydrocharitaceae) in northeastern North America. Rhodora 84:523-545.

Case, F. W., Jr.; Catling, P. M. 1983. The genus Spiranthes in Michigan. Mich. Bot. 22:79-92.

Chillcott, J.; Teskey, H. J. 1983. A revision of the new world genera allied to *Megagrapha* Melander (Diptera: Empididae). Can. Entomol. 115:1291-1328.

Cody, W. J. 1983. *Adiantum pedatum* ssp. *Calderi*, a new subspecies in northeastern North America. Rhodora 85:93-94.

Dalpé, Y. 1983. L'influence de la carence en pyridoxine sur la morphologie et l'ultrastructure cellulaire de *Ceratocystis ulmi*. Can. J. Bot. 61:2079-2084.

Dondale, C. D.; Redner, J. H. 1983. Revision of the wolf spiders of the genus *Arctosa* C.K. Koch in North and Central America (Araneae: Lycosidae). J. Arachnol. 11:1-30.

Dondale, C. D.; Redner, J. H. 1983. The wolf spider genus *Allocosa* in North and Central America (Araneae: Lycosidae). Can. Entomol. 115:933-964.

Ebsary, B. A. 1982. Canadian species of *Tobrilus* (Nematoda: Tobrilidae) with description of three new species. Can. J. Zool. 60:3048-3062.

Ebsary, B. A. 1982. *Bakernema yukonense* n. sp. (Nematoda: Criconematidae) with keys to the species of *Criconemella* and *Disocriconemella*. Can. J. Zool. 60:3033-3047.

Ebsary, B. A. 1983. *Pungentus porosus* n. sp. (Nematoda: Dorylaimoidea) from Canada with a key to the species of *Pugnentus*. J. Nematol. 15:364-366.

Faris, M. A.; Sabo, F. E.; Barr, D. J. S. 1983. Studies on *Phytophthora megasperma* isolates with different levels of pathogenicity on alfalfa cultivars. Can. J. Plant Pathol. 5:29-33.

Ferris, C. D.; Dos Passos, C. F.; Ebner, J. A.; Lafontaine, J. D. 1983. An annotated list of the butterflies (Lepidoptera) of the Yukon Territory, Canada. Can. Entomol. 115:823-840.

Ginns, J. 1982. A monograph of the genus Coniophora (Aphyllophorales, Basidiomycetes). Opera Bot. 61:7-61.

Ginns, J.; Lowe, J. L. 1983. *Macrohyporia extensa* and its synonym *Poria cocos*. Can. J. Bot. 61:1672-1679.

Goulet, H. 1983. The genera of Holarctic Elaphrini and species of *Elaphrus* Fabricius (Coleoptera: Carabidae): Classification, phylogeny and zoogeography. Quaest. Entomol. 19:219-482.

Goulet, H.; Bousquet, Y. 1983. Description of a new *Pterostichus* (Coleoptera: Carabidae) from Beaver houses in eastern North America. Can. Entomol. 115:281-286.

Goulet, H.; Smetana, A. 1983. A new species of *Blethisa* Bonelli from Alaska, with proposed phylogeny, biogeography and key to known species (Coleoptera: Carabidae). Can. Entomol. 115:551-558.

Greenhalgh, R.; Neish, G. A.; Miller, J. D. 1983. Deoxynivalenol, acetyl deoxynivalenol, and zearalenone formation by Canadian isolates of *Fusarium graminearum* on solid substances. Appl. Environ. Microbiol. 46:625-629.

Hamilton, K. G. A. 1982. The insects and arachnids of Canada. Part 10. The spittlebugs of Canada. Homoptera: Cercopidae. Agric. Can. Publ. No. 1740. 102 pp.

Hamilton, K. G. A. 1983. Synopsis of *Typhlocyba* subgenus *Empoa* Fitch, with a key to the species of the *Gillettei* complex (Rhynchota: Homoptera: Cicadellidae). Can. Entomol. 115:67-73.

Hamilton, K. G. A. 1983. Introduced and native leafhoppers common to the old and new worlds (Rhynchota: Homoptera: Cicadellidae). Can. Entomol. 115:473-511.

Hamilton, K. G. A. 1983. Revision of the Macropsini and Neopsini of the new world (Rhynchota: Homoptera: Cicadellidae), with notes on intersex morphology. Mem. Entomol. Soc. Can. No. 123. 223 pp.

Hamilton, K. G. A. 1983. Classification, morphology and phylogeny of the family Cicadellidae (Rhynchota: Homoptera). *In* Commonwealth Institute of Entomology. 1st International Workshop on leafhoppers and planthoppers of economic importance. pp. 15-37.

Hardwick, D. F. 1983. A new species of *Schinia* (Noctuidae) from central Florida, with description of its life history. J. Lepid. Soc. 37:148-154.

Hardwick, D. F. 1983. A new species of *Schinia* (Noctuidae) from Manitoba and Saskatchewan with description of its life history. J. Lepid. Soc. 37:18-23.

Hoebeke, E. R.; Hamilton, K. G. A. 1983. *Lepyronia coleoptrata* (L.), a European spittlebug in eastern North America: New locality records and new key to the North America species of *Lepyronia* Amyot & Serville (Homoptera: Cercopidae). Proc. Entomol. Soc. Wash. 85:263-271.

Hudson, A. 1983. Comparative studies of the development of two species of spotted cutworm *Xestia adela* and *Xestia dolosa* (Lepidoptera: Noctuidae) and identification of larvae by electrophoresis. Proc. Entomol. Soc. Wash. 85:612-618.

Huggert, L.; Masner, L. 1983. A review of Myrmecophilic-symphilic diapriid wasps in the Holarctic realm, with descriptions of new taxa and a key to genera (Hymenoptera: Proctotrupoidea: Diapriidae). Contrib. Am. Entomol. Inst. 20:63-89.

Huggert, L.; Masner, L. 1983. Two new genera of African scelionid wasps (Hymenoptera, Proctotrupoidea: Scelionidae). Entomol. Scand. 14:173-185.

Hughes, S. J. 1983. Five species of *Scarcinella* from North America, with notes on Questieriella n. gen., *Mitteriella, Endophragmiopsis, Schiffnerula,* and *Clypeolella*. Can. J. Bot. 61:1727-1767.

Hughes, S. J. 1983. New Zealand Fungi 32. *Jänetia capnophila* sp. nov. and some allies. N.Z. J. Bot. 21:177-182.

Hughes, S. J.; Cavalcanti, W. de A. 1983. *Jänetia mangiferae* n. sp., and the *Johncouchia* n. gen. anamorph of *Septobasidium pilosum* from Brasil. Can. J. Bot. 61:2224-2230.

Kangasniemi, B. J.; Oliver, D. R. 1983. Chironomidae (Diptera) associated with *Myriophyllum spicatum* in Okanagan Valley Lakes, British Columbia. Can. Entomol. 115:1545-1546.

Kelton, L. A. 1983. European *Pseudoloxops coccineus* found in Canada, and additional records of *Camptozygum aequale* in the Nearctic region (Heteroptera: Miridae). Can. Entomol. 115:107-108.

Kelton, L. A. 1983. Four European species of *Psallus* Fieber found in Canada (Heteroptera: Miridae). Can. Entomol. 115:325-328.

Kelton, L. A. 1983. Plant bugs on fruit crops in Canada. Heteroptera: Miridae. Agric. Can. Monogr. 24. 201 pp.

Lafontaine, J. D.; Mikkola, K.; Kononenko, V. S. 1983. A revision of the genus *Xestia* (subgenus *Schoyenia*) (Lepidoptera: Noctuidae) with descriptions of four new species and a new subspecies. Entomol. Scand. 14:337-369.

LeSage, L. 1982. The immature stages of *Exema canadensis* Pierce (Coleoptera: Chrysomelidae). Coleopt. Bull. 36:318-327.

LeSage, L. 1983. Note sur la distribution présente et future du Criocère du Lys, *Lilioceris lilii* (Scopoli) (Coleoptera: Chrysomelidae) dans l'est du Canada. Nat. Can. 110:95-97.

LeSage, L. 1983. The larva and pupa of *Cytilus alternatus* Say (Coleoptera: Byrichidae). Coleopt. Bull. 99-105.

Masner, L. 1983. The genus *Oethecoctonus* Ashmead in North America (Hymenoptera: Proctotrupoidea: Scelionidae). Can. Entomol. 115:17-24.

Masner, L. 1983. A revision of *Gryon* Haliday in North America (Hymenoptera: Proctotrupoidea: Scelionidae). Can. Entomol. 115:123-174.

Masner, L. 1983. Revision of the Nearctic species of *Trichacis* Foerster (Hymenoptera: Proctotrupoidea: Platygastridae). Can. Entomol. 115:1071-1093.

Mason, W. R. M. 1982. A new South African subfamily related to Cardiochilinae (Hymenoptera: Braconidae). Contrib. Am. Entomol. Inst. 20:49-62.

Matsuda, R. 1983. Evolutionary process of animals in changing environments (1) (in Japanese). Seibutsu Kagaku 35:113-121.

McAlpine, J. F. 1983. A revision of the genus *Protearomyia* McAlpine (Diptera: Lonchaeidae). Can. Entomol. 115:885-903.

McNeill, J.; Bassett, I. J.; Crompton, C. W.; Taschereau, P. M. 1983. Taxonomic and nomenclatural notes on *Atriplex* L. (Chenopodiaceae). Taxon 32:549-556.

Mulligan, G. A.; Munro, D. B.; McNeill, J. 1983. The status of *Stachys palustris* (Labiatae) in North America. Can. J. Bot. 61:679-682.

Neish, G. A.; Franworth, E. R.; Greenhalgh, R.; Young, J. C. 1983. Observations on the occurrence of *Fusarium* species and their toxins in corn in Eastern Ontario. Can. J. Plant Pathol. 5:11-16.

Oliver, D. R.; Roussell, M. E. 1983. Redescription of *Brillia* Kieffer (Diptera: Chironomidae) with descriptions of Nearctic species. Can. Entomol. 115:257-279.

Oliver, D. R.; Roussell, M. E. 1983. The insects and arachnids of Canada. Part 11. The genera of larval midges of Canada. Diptera: Chironomidae. Agric. Can. Publ. 1746. 263 pp.

Parmelee, J. A. 1983. The fungi of Ontario. III. Parasitic microfungi on vascular plants in northern Ontario. Agric. Can. Res. Br. Contr. 9-E. 87 pp.

Pechuman, L. L.; Webb, D. W.; Teskey, H. J. 1983. The Diptera, or true flies of Illinois. I. Tabanidae. Bull. Ill. Nat. Hist. Surv. 33:1-121.

Redhead, S. A. 1982. The systematics of *Callistosporium luteoolivaceum*. Sydowia 35:223-235.

Redhead, S. A.; Smith, A. H. 1983. *Lactarius neotabidus* nov. for *Lactarius canadensis*. Mycotaxon 17:521-522.

Redhead, S. A.; Catling, P. M. 1983. Two Sable Island fungi, *Peziza ammophila* and *Hygrocybe turunda* new to Nova Scotia. Can. Field-Nat. 97:102-103.

Ritchie, A. J.; Masner, L. 1983. Revision of the Nearctic species of *Baryconus* (Hymenoptera: Scelionidae). Can. J. Zool. 61:704-720.

Schmid, F. 1983. Revision des Trichoptères canadiens. III. Les Hyalopsychidae, Psychomyiidae, Goeridae, Brachycentridae, Sericostomatidae, Helicopsychidae, Beraeidae, Odontoceridae, Calamoceratidae et Molannidae. Mem. Soc. Entomol. Can. No. 125. 109 pp.

Sharkey, M. J. 1983. *Marjoriella*, a new neotropical genus of Agathidinae (Braconidae, Hymenoptera). Contrib. Am. Entomol. Inst. 20:94-100.

Small, E.; Lefkovitch, L. P. 1982. Agrochemotaxometry of alfalfa. Can. J. Plant Sci. 62:919-928.

Small, E.; Lefkovitch, L. P.; Classen, D. 1982. Character set incongruence in *Medicago*. Can. J. Bot. 60:2505-2510.

Small, E.; Brookes, B. S. 1983. The systematic value of stigma morphology in the legume tribe Trifolieae with particular reference to *Medicago*. Can. J. Bot. 61:2388-2404.

Smetana, A. 1982. Remarks on some Xantholininae from the Kuril Islands (Coleoptera: Staphylinidae). Coleopt. Bull. 36:309-313.

Smetana, A. 1983. The status of the staphylinid genera *Derops* Sharp and *Rimulincola* Sanderson (Coleoptera). Entomol. Scand. 14:269-279.

Smetana, A. 1983. Geographical distribution of the water beetle genus *Hydrochara* (Coleoptera, Hydrophilidae). Spec. Issue Aquat. Coleopt. Work. 16. Int. Congr. Entomol. Kyoto. pp. 27-33.

Smith, I. M. 1983. Description of *Cowichania interstitialis* n. gen., n. sp., and proposal of Cowichaninae n. subfam. with remarks on phylogeny and classification of Hydryphantidae (Acari: Parasitengona: Hydryphantoidea). Can. Entomol. 115:523-527.

Smith, I. M. 1983. Description of larvae and adults of *Paramideopsis susanae* n. gen., n. sp., with remarks on phylogeny and classification of Mideopsidae (Acari: Parasitengona: Arrenuroidea). Can. Entomol. 115:529-538.

Smith, I. M. 1983. Descriptions of two new species of *Acalyptonotus* from western North America, with a new diagnosis of the genus based upon larvae and adults, and comments on phylogeny and taxonomy of Acalyptonotidae (Acari: Parasitengona: Arrenuroidea). Can. Entomol. 115:1395-1408.

Smith, I. M. 1983. Description of the adults of a new species of *Uchidastygacarus* (*s.s.*) (Acari: Parasitengona: Arrenuroidea) from eastern North America, with comments on distribution of mites of the genus. Can. Entomol. 115:1177-1179.

Smith, I. M. 1983. Description of adults of a new species of *Geayia* (Acari: Parasitengona: Krendowskiidae) from southern Ontario. Can. Entomol. 115:1489-1492.

Smith, I. M. 1983. Description of adults of a new species of *Cyclothyas* (Acari: Parasitengona: Hydryphantidae) from western North America, with comments on phylogeny and distribution of mites of the genus. Can. Entomol. 115:1433-1436.

Smith, I. M. 1983. Description of larvae of *Neoacarus occidentalis* (Acari: Arrenuroidea: Neocaridae). Can. Entomol. 115:221-226.

Smith, I. M. 1983. Description of adults of *Neomideopsis siuslawensis* n. gen., n. sp., with remarks on the family Mideopsidae (Acari: Parasitengona: Arrenuroidea). Can. Entomol. 115:417-420.

Smith, I. M. 1982. Description of larvae of *Nudomideopsis magnacetabula* (Acari: Arrenuroidea: Mideopsidae) with new distributional records for the species and remarks on the classification of *Nudomideopsis*. Can. Entomol. 115:913-919.

Stewart, W. E.; Bright, D. E. 1982. Notes on *Pissodes fiskei* (Coleoptera: Curculionidae) with a redescription of the species. Coleopt. Bull. 36:445-452.

Teskey, H. J. 1983. A review of the *Atylotus insuetus* group from western North America including description of a new species and immature stages (Diptera: Tabanidae). Can. Entomol. 115:693-702.

Thompson, F. C.; Vockeroth, J. R.; Speight, M. C. D. 1982. The linnean species of flower flies (Diptera: Syrphidae). Mem. Entomol. Soc. Wash. 10:150-165.

Vockeroth, J. R. 1982. Nomenclatural notes on Nearctic Syrphinae, with descriptions of new species of *Syrphus* and keys to Nearctic species of *Didea, Epistrophe s. str.* and *Syrphus* (Diptera: Syrphidae). Can. Entomol. 115:175-182.

Warwick, S. I.; McNeill, J. 1982. Population variation in *Plantago major* from southern Ontario. Can. J. Bot. 60:2846-2856.

Warwick, S. I.; Black, L. D. 1983. The biology of Canadian weeds. 61. *Sorghum halepense* (L.) Pers. Can. J. Plant Sci. 63:997-1014.

Warwick, S. I.; Sweet, R. D. 1983. The biology of Canadian weeds. 58. *Galinsoga parviflora* and *G. quadriradiata* (*G. ciliata*). Can. J. Plant Sci. 63:695-709.

Wood, D. M.; Borkent, A. 1982. Description of the female of *Parasimulium crosskeyi* Peterson (Diptera: Simuliidae) and a discussion of the phylogenetic position of the genus. Mem. Entomol. Soc. Wash. 10:193-210.

Yoshimoto, C. M. 1983. Review of North American *Pnigalio* Schrank (Hymenoptera: Eulophidae). Can. Entomol. 115:971-1000.

Yoshimoto, C. M. 1983. A new genus of Tetrastichinae from the new world (Hymenoptera: Chalcidoidea: Eulophidae). Contrib. Am. Entomol. Inst. 20:90-93.

Miscellaneous

Barr, D. J. S. 1983. The zoosporic grouping of plant pathogens Entity or nonentity? Pages 43-83 *in* Zoosporic plant pathogens A modern perspective. Buczacki, S. T., ed. Academic Press, London.

Barr, D. J. S. 1983. The genera of phytopathogenic zoosporic fungi. Pages 293-320 *in* Zoosporic plant pathogens A modern perspective. Buczacki, S. T., ed. Academic Press, London.

Bassett, I. J.; Crompton, C. W. 1983. *Atriplex* L. and *Chenopodium* L. J.G. Packer. *In* Flora of Alberta, 2nd ed. University of Toronto Press, Toronto, Ontario. pp. 236-239; 240-245.

Baum, B. R. 1983. Tamarix L. *In* Contribution à l'étude de la flore et de la végétation des deserts d'Iran. Leonard, J., ed. Fascicule 3. Jardin botanique national de Belgique.

Bissett, J. D. 1983. *Septoria bromi*. Fungi Can. No. 241.

Bissett, J. D. 1983. *Septoria elymi*. Fungi Can. No. 242.

Bissett, J. D. 1983. *Septoria passerinii*. Fungi Can. No. 243.

Bissett, J. D. 1983. *Septoria tritici*. Fungi Can. No. 244.

Catling, P. M. 1983. Terrestrial orchids in Canada. Pages 87-132 *in* Plaxton, E. H., ed. North American terrestrial orchids, Symposium 11, Proceedings and Lectures, Michigan Orchid Society, Southied, Michigan. 143 pp.

Ginns, J. 1983. *Peziza proteana*. Fungi Can. No. 249.

Ginns, J.; Egger, K. 1983. *Sowerbyella imperialis*. Fungi Can. No. 249.

Hughes, S. J. 1983. *Helminthosporium oligosporum*. Fungi Can. No. 245.

Hughes, S. J. 1983. *Cordana inaequalis*. Fungi Can. No. 246.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium betulicola*. Fungi Can. No. 251.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium pithoideum*. Fungi Can. No. 252.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium obliquum* var. *obliquum*. Fungi Can. No. 253.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium obliquum* var. *suttonii*. Fungi Can. No. 254.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium cedricola*. Fungi Can. No. 255.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium obovatum*. Fungi Can. No. 256.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium spilomeum*. Fungi Can. No. 257.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium biformatum*. Fungi Can. No. 258.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium traversianum*. Fungi Can. No. 259.

Hughes, S. J.; White, G. P. 1983. *Bactrodesmium rahmii*. Fungi Can. No. 260.

LeSage, L.; Bousquet, Y. 1983. A new record of attacks by *Pedilus* (Pedilidae) on *Meloe* (Meloidae: Coleoptera). Entomol. News 94:95-96.

Mulligan, G. A.; Munro, D. B. 1983. Vascular plants poisonous to livestock in Canada. 1. A preliminary inventory. Agric. Can. Tech. Bull. Contrib. 23E. 33 pp.

Savile, D. B. O. 1983. *Puccinia striformis*. Fungi Can. No. 250.

Chemistry and Biology Research Institute

Ottawa, Ontario

PROFESSIONAL STAFF

A. I. de la Roche, B.Sc., M.S., Ph.D.	Director
D. Buckland	Administrative Officer

Symbiotic Nitrogen Fixation

R. W. Miller, B.S., Ph.D.	Program Leader; Rhizobium and legume physiology
E. S. P. Bromfield, B.Sc., Ph.D.	Rhizobium ecology
S. M. Lesley, B.Sc., M.A., Ph.D.	Rhizobium physiology
F. D. H. MacDowall, F.Sc., M.Sc., Ph.D.	Legume physiology
C. Preston, B.Sc., M.Sc., Ph.D.	Soil nitrogen
L. R. Barran, B.Sc., M.Sc., Ph.D.	Program Leader; Rhizobium genetics
R. M. Behki, B.Sc., M.Sc., Ph.D.	Rhizobium genetics
R. J. Watson, B.Sc., M.Sc., Ph.D.	Rhizobium genetics

Stress Physiology

M. K. Pomeroy, B.Sc., M.Sc., Ph.D.	Program Leader; Winter survival of cereals
C. J. Andrews, B.Sc., Ph.D.	Winter survival of cereals
Y. Cloutier, B.Sc., M.Sc., Ph.D.	Desiccation stress
E. F. Schneider, B.S., M.Sc., Ph.D.	Snow mold damage
J. Singh, B.S., Ph.D.	Freezing injury—membranes

Mycotoxins

R. Greenhalgh, B.S., Ph.D.	Program Leader; Analytical and natural products chemistry
J. D. Miller, B.Sc., M.Sc., Ph.D.	Fungal physiology
H. Morita, B.Sc., M.Sc., Ph.D.	Organic chemistry

J. C. Young, B.Sc., M.Sc., Ph.D.	Analytical and natural products chemistry

Plant Pathology

R. C. Sinha, B.Sc., M.Sc., Ph.D., D.Sc.	Program Leader; Virus and mycoplasma vector relationships
L. N. Chiykowski, B.S.A., M.Sc., Ph.D.	Leafhopper-transmitted mycoplasma
Y. C. Paliwal, B.S.A., M.Sc., Ph.D.	Aphid- and mite-transmitted viruses

Environmental Chemistry

S. U. Khan, B.Sc., M.Sc., Ph.D., F.C.I.C., F.R.I.C.	Program Leader; Herbicides
D. S. Gamble, B.Sc., M.Sc., Ph.D., F.C.I.C.	Herbicide chemistry
A. Picman, M.Sc., Ph.D.	Phytochemistry

Soil Chemistry and Mineralogy

M. Schnitzer, B.Sc. (Agr.), M.Sc., Ph.D., F.C.S.S., F.A.S.A., F.S.S.S.A.	Program Leader; Soil chemistry organic matter
L. M. Benzing-Purdie, B.Sc., M.Sc., Ph.D.	Soil nitrogen
Y. K. Chan, B.Sc., Ph.D.	Soil microbiology
K. C. Ivarson, B.Sc., M.Sc., Ph.D.	Soil microbiology

H. Kodama, B.Sc., M.Sc., D.Sc.	Program Leader; Soil mineralogy crystal chemistry
M. Ihnat, B.Sc., Ph.D.	Trace element chemistry
N. M. Miles, B.Sc.	Soil mineralogy
G. J. Ross, B.S.A., M.Sc., Ph.D.	Soil mineralogy
S. S. Singh, B.Sc., M.Sc., Ph.D.	Soil chemistry

Mineral Analyses Service

H. Kodama, B.Sc., M.Sc., D.Sc.	Head of Services

Analytical Chemistry Services

M. Ihnat, B.Sc., Ph.D.	Head of Services

Electron Microscope Centre

I. L. Stevenson, B.S.A., M.S.A., Ph.D.	Program Leader
G. H. Haggis, B.Sc., Ph.D.	Electron microscopy

Honorary Research Associate

D. Siminovitch, B.Sc., M.Sc., Ph.D., F.R.S.C.	Frost hardiness

VISITING SCIENTISTS

B. Blackwell, B.Sc., M.Sc., Ph.D. National Research Council visiting fellow	Biospectroscopy
G. Catroux Ingenieur Agronome, INRA, Dijon, France	Soil nitrogen
A. H. Khadhair, B.Sc., M.Sc. Postgraduate student	Plant virology
R. Moody, Ph.D. Health and Welfare Canada, Ottawa, Ont.	Pesticide chemistry
M. Spiteller, Ph.D. University of Bayrenth, Bayrenth, West Germany	Soil organic matter
Lian-Zhong Zhang Institute of Environmental Chemistry, Academica Sinaca, Beijing, The Peoples Republic of China	Environmental Chemistry

INTRODUCTION

The Chemistry and Biology Research Institute (CBRI) carries out research and development in areas of national significance to agriculture, such as food safety, conservation of natural resources and energy, biotechnology, and the negation of environmental pollution. Multidisciplinary teams working on mycotoxins and nitrogen fixation have responded to the hazards to health and the economy of fungal metabolites in food and feeds and to the need of increasing the nitrogen-fixing capacity of forage legumes through conventional technologies and the new biotechnology. Emphasis in the stress physiology program has shifted toward combining genetic engineering technology with our knowledge of mechanisms of stress injury and resistance in order to develop crops resistant to low temperature, drought, and salinity stresses. Successful utilization of an acidophilic fungus for conversion of lignocellulosic wastes into single-cell protein and its potential use in the production of ethanol have generated considerable commercial interest. Other notable achievements in 1983 include the development of immunological methods for rapid diagnosis of peach-X disease and the development of a simple mathematical model for predicting the persistence of the herbicide atrazine in cultivated soils.

The acquisition of new resources in 1983 enabled the Institute to expand substantially its efforts in biotechnology. Increasing emphasis has been placed on plant and fungal molecular genetics and the application of recombinant DNA techniques to crop production, protection, and nitrogen fixation. The functional capacity of the Electron Microscope Centre and the Analytical Chemistry and Mineral Analyses Services was enhanced by acquisition of new instruments and by modification of existing equipment. While basic research remains the principal thrust of the Institute's activities, technology transfer to industry and other public research organizations is an ever-increasing priority. During the past year, the Institute initiated collaborative projects with eight Canadian industries.

The Institute was deeply saddened by the death of Dr. J. C. Sirois, who contributed significantly in the fields of plant growth regulators and nitrogen fixation and had retired in March 1983. Dr. Sirois will be sorely missed by his colleagues and friends.

This report summarizes only the highlights of our achievements in 1983. Reprints of research publications and copies of this report are available from the Chemistry and Biology Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

A. I. de la Roche
Director

SYMBIOTIC NITROGEN FIXATION

Rhizobium ecology

Stable high-level antibiotic-resistant (streptomycin, spectinomycin, and kanamycin) strains of *Rhizobium meliloti* necessary for determining competitive ability with alfalfa have been developed. A number of highly competitive *R. meliloti* isolates have been characterized by phage typing. Effects of alfalfa cultivar genotype on effectiveness of the rhizobium inoculant strains were examined and found to be a major factor in determining strain competitive ability.

Rhizobium genetics

The screening of transposon (Tn5) induced mutants of *R. meliloti* was completed. Of 8000 mutants examined, 130 were deficient in nitrogen fixation (Nif^-) while a number of mutants were partially deficient in nitrogen fixation and two non-nodulating mutants. The transposons are being cloned out of the *R. meliloti* genome and classified with regard to their location.

A plasmid of *R. leguminosarum* containing the hydrogen-uptake (Hup) genes was transferred into *R. meliloti* by conjugation. Preliminary experiments indicate that *R. meliloti* transconjugants show significant hydrogenase activity. Experiments in progress are focused on the further characterization of newly introduced Hup system in *R. meliloti*.

Bacteroid and nodule physiology

The effect of low temperature, water deficiency, and other environmental stresses on whole nodules was examined by low-temperature electron spin resonance spectroscopy. Nitrogenase of normal nodules was found to be tightly coupled to respiration. Extremes of short-term physiological stress caused destructive oxidation of nitrogenase and leghemoglobin.

Calcium ion exerted a significant effect on bacteroid cytoplasmic membranes, decreasing membrane fluidity while increasing both respiration rate and membrane electrical potential. Extracellular calcium and magnesium ions acted similarly in stimulating respiration-supported nitrogenase activity of isolated bacteroids.

Host physiology and infection processes

Studies of energy supply for nitrogen fixation in alfalfa revealed that the energy efficiency of the symbiotic process varies markedly with ambient temperature. The binding reaction between seed lectin and specific carbohydrates was followed directly by nuclear magnetic resonance (NMR) spectroscopy. Ultimately this method will yield valuable information on critical recognition phenomena during the early stages of infection and nodulation. Further studies aimed at quantitative determination of the contribution of biologically fixed nitrogen to the growth of forage legumes were carried out with an improved ^{15}N emission spectrometer.

STRESS PHYSIOLOGY

Field and controlled-environment studies

Spring survival of several winter wheat cultivars in experimental plots and in commercial plantings in eastern and central Ontario was generally good in 1983. Because of an unusually mild autumn, later than usual plantings gave the highest cold hardiness, ice tolerance, and overall winter survival. However, the mild conditions resulted in considerable damage due to ice encasement in low-lying areas. Screening of 90 winter wheat and triticale cultivars and lines under artificially modified field and controlled-environment conditions revealed superior ice tolerance in Lutescens 329.

Significant snow mold damage did not occur in this area in 1983 because of lack of snow accumulation but high incidences of septoria, tan spot, and eye spot symptoms were observed. Sclerotia from over 100 isolates were tested for pathogenicity under controlled-environment conditions and with few exceptions, the sclerotia produced viable pathogens that destroyed winter wheat seedlings. This method can now be used to effectively screen large populations of winter cereals for resistance to snow mold diseases.

Chilling sensitivity in soybeans

Investigations of imbibitional chilling injury in soybeans revealed no significant differences in phospholipid composition of axes from chilling-sensitive and chilling-resistant seedlings derived from the same cultivar matured at high and low temperatures. However, the amounts of phospholipid present were significantly higher in axes that were tolerant to imbibitional chilling. Imbibing seeds may not be able to synthesize sufficient amounts of phospholipid and must rely on existing phospholipids for cellular expansion.

Freezing and desiccation stress

Plasma membrane proteins were analyzed by electrophoresis, and protein changes observed following desiccation stress were not correlated with freezing tolerance. Protoplasts were isolated from three winter rye cultivars of contrasting frost hardiness and their soluble and membrane proteins were analyzed by two-dimensional electrophoresis. Several protein changes were observed following cold acclimation and desiccation stress, and one protein fraction has been correlated with freezing tolerance.

Further insight into the molecular mechanisms of freezing injury in winter wheat was gained through studies with cell-size, artificial, single-bilayered liposomes. Lipid analysis revealed that the liposomes did not contain enclosed lipids, but cholesterol and neutral triglycerides, as well as phospholipids, were detected in the membranes. ^{31}P-NMR and ultrastructural experiments using the desiccation-tolerant moss *Tortula ruralis* have further substantiated the hypothesis that one mechanism of freezing and dehydrative injury involves the loss of extended bilayers in cellular membranes during lethal freezing. This moss can withstand repeated cycles of extreme drying and freezing to liquid nitrogen temperature without the loss of extended bilayers in its membranes. Furthermore, in the desiccated state endoplasmic reticulum vesicles can fuse with the plasma membrane to form an extended supply of membrane material to enable the moss to retain compartmentation on rehydration.

Isolated cell and tissue culture studies

Studies on the effect of environmental stresses on physiological and biochemical processes of winter wheat have provided evidence that the ion transport system of the cell is a primary site of low-temperature injury. Low-temperature stresses rapidly reduced the uptake of ^{86}Rb by isolated winter wheat cells, while passive efflux of label from cells occurred more gradually, indicating that the energy-dependent ion-transport system is damaged prior to general loss of membrane semipermeability.

The ability of alfalfa cells in culture to cold acclimate was found to be dependent on the exclusion of kinetin from the culture medium. The presence of abscisic acid in the medium had minimal effect on hardening, whereas the addition of a lipotropic agent, choline chloride, enhanced cold acclimation. Techniques were developed for cold hardening of cultured plantlets derived from subepidermal explants of haploid winter and spring rape, and the feasibility of utilizing such a system as a selection mechanism for hardier rape plants is currently being assessed.

MYCOTOXINS

Deoxynivalenol

Fermentation studies have identified some of the nutritional factors in the biosynthesis of deoxynivalenol (DON) and related compounds in Canadian, Japanese, and English isolates of trichothecene-producing *Fusarium*. Several minor secondary metabolites have been isolated from crude fungal extracts of liquid cultures of *F. graminearum*; these include culmorin, 7-deoxy-DON, and three new trichothecenes. A new process for the production of 3-acetyl-DON has been developed by Atlantic Regional Laboratories/ National Research Council and CBRI using shake cultures of *F. culmorum*. The process using *F. graminearum* (*roseum*) has been transferred to Research Foods, Toronto, for commercial exploitation.

Processing of contaminated grain

Ontario soft white winter wheat naturally contaminated with deoxynivalenol (0.45 mg/ kg) was cleaned and milled in industrial, pilot, and experimental mills. Agreement obtained between the various mills was good and showed higher levels in the bran, shorts, and middling fraction and lower levels in the flour. Cakes, cookies, doughnuts, and bran breakfast cereals were processed from the flour. For all products, the combined effects of milling, dilution, and baking gave an average reduction of 66% in DON.

Field studies

Chemical and mycological analyses of winter wheat experimentally infected with *F. graminearum* showed DON (10 ppm) in the heads, despite a hot dry summer. Levels of DON peaked prior to harvest, a phenomenon observed in a similar experiment with field corn and in natural infections. Traditional disease assessment methods failed to detect the extent of fungal infection and toxin concentrations. Varieties of resistant and susceptible wheat, rye, and triticale were artificially infected with *F. graminearum*. Significant levels of DON were found in wheat kernels (7 ppm) and chaff (60 ppm) of the susceptible varieties, but little or none was found in the resistant species. In both cases the fungal metabolite, ergosterol, was used to assess fungal biomass. The ergosterol-to-DON ratio has the potential for distinguishing between resistant and susceptible varieties.

Microbiology

The acidophilic fungus *Sytalidium acidophilum* was found to have a yeast-like stage and produces alcohol from both 6-C and 5-C sugars at the low pH of 1.0. Its ability to assimilate both types of sugars at low pH values could make it the organism of choice for producing alcohol from wood and farm produce wastes. The protein produced by the fungus also has an appropriate digestibility for use as an animal feed supplement.

Analysis

Mass spectra fragmentation patterns for several trichothecene mycotoxins and their derivatives have been worked out based on linked-scan experiments. These data were utilized in the development of a procedure for monitoring crude fungal extracts for the presence of 3-acetyl-DON and its precursors by fast-atom-bombardment mass spectroscopy.

PLANT PATHOLOGY

Peach X-disease

An antiserum against peach X-mycoplasma (PXM) was prepared using purified preparations of the pathogen from infected celery, a herbaceous host of the fruit-tree disease. Procedures were then developed for detecting PXM-antigens by enzyme-linked immunosorbent assay (ELISA) in purified or partially purified preparations obtained from infected plants. The absorbance ($A_{405\ \mathrm{nm}}$) values with PXM-antigens were always significantly higher than those with control preparations from healthy plants. The mycoplasmalike organisms were also detected specifically by immunosorbent electron microscopy (IEM) in extracts prepared from 5-g samples of the diseased leaves. Both ELISA and IEM methods would be useful in detecting PXM in herbaceous hosts that may serve as reservoirs of the pathogen. The transmission studies on PXM showed that late-instar nymphs and adults of the vector leafhopper *Paraphlepsius irroratus* (Say) were more efficient in acquiring PXM from Ladino clover than were early-instar nymphs. Susceptibility of celery to PXM generally decreased with increasing age of plants. Transmission to celery ranged from 38% to 88% with inoculation access period (IAP) of 1–8 days. With wild carrots, however, the transmission was only 6% even after a 8-day IAP.

Aster yellows disease

A procedure was developed for the detection of aster yellows mycoplasma (AYM), by IEM, in the vector leafhopper *Macrosteles fascifrons* Stal after they had been exposed to infected plants. The results showed that the technique can be used for detection of AYM in the extracts prepared from individual exposed leafhoppers. In other studies, it was demonstrated that AYM is serologically unrelated to *Spiroplasma citri*. Furthermore, only nonhelical organisms were observed in IEM tests on the electron microscope grids coated with AYM antiserum and then treated with the clarified extracts from various plant species infected with aster yellows. These results provide strong evidence against the claim that aster yellows agent is a variant of *S. citri*.

Forage legume diseases

White clover mosaic virus (WCMV) particles were observed in the cytoplasm of nodular cells and in the nuclei of some meristematic and transfer cells of the nodules produced by *Rhizobium trifolii* in red clover plants. The virus particles were seen in close proximity to, but not inside the bacteroids located in the nodules. WCMV infection of the plants accelerated the senescence of the nodules. The virus infection also caused a significant reduction of leghemoglobin concentration in the nodules, thereby contributing to the reduction of the N_2-fixing capacity of the nodules. The Canadian strain of lucerne transient streak virus (LTSV) was distinguished from the Australasian strains by its host reactions. Six food legumes were newly recognized as hosts of the virus. LTSV contained a single sedimenting component of $S_{20\ \mathrm{W}} = 113$ S and had a buoyant density of 1.361 in cesium. LTSV contains 18% ssRNA and one species of protein of mol wt 32 200. Viral protein had high levels of alanine, aspartic acid, threonine, serine, and proline. Electrophoresis and electron microscopy revealed a large linear RNA and a circular viroid-like RNA in the virions a rare RNA complement for plant viruses. LTSV-RNA, therefore, can be used in gene-splicing experiments.

ENVIRONMENTAL CHEMISTRY

Nonbiological degradation of pesticides

Photolysis of chlorothalonil when exposed to sunlight or low-energy ultraviolet irradiation was followed with a steady decrease of the parent compound and mono-adduct concentration with concomitant increase in di-adduct. The results demonstrated the possibility of nonbiological degradation of the fungicide in sunlight under field conditions.

Studies on the photodecomposition of the herbicide promotryn showed that dissolved humic materials present in agricultural waters and soil solutions sensitized the photolysis of *S*-triazines. The hydroxyl radicals generated by photolytic process dealkylated the herbicide. The results demonstrated the importance of indirect photolytic processes that may be initiated by naturally occurring organic material, such as humic substances, when assessing the fate of synthetic chemical under field conditions.

A simplified mathematical equation was developed for predicting the half-life of atrazine in fulvic acid solution. Binding of atrazine to dissolved soil organic matter was strongly influenced by aggregation. Experimental conditions that control aggregation were determined and it was shown that pH and metal ion concentration influence the sorption and movement of atrazine in agricultural soils.

Fate of atrazine in resistant and susceptible weeds

The fate and metabolism of atrazine between susceptible and resistant biotypes showed a similar pattern in the three species representing two genera. Although parent atrazine levels were similar in both biotypes of the three weed species, the resistant biotypes in each case contained a higher level of polar conjugates and bound residues in the plant tissue. In contrast, presence of a phytotoxic metabolite was only observed in the susceptible biotype of the three weed species.

Bound pesticide residues in food crops

^{14}C-Dieldrin, ^{14}C-permethrin, and ^{14}C-carbofuran were applied in commercial formulations to radishes at 11.1 kg/ha and maintained in environmental growth chambers. Edible portions of the radishes were sampled 21 days after application and analyzed for bound (nonextractable) residues. The amounts of bound ^{14}C residues formed in the radishes treated with dieldrin, permethrin, and carbofuran were 23.5%, 28.6%, and 92.6%, respectively, of the total plant ^{14}C. Bound ^{14}C residues in radishes were present in the form of parent pesticide or metabolites of similar chemical structure. It was suggested that bound residues in radishes were formed by a process involving chemical entrapment of the pesticide or its metabolites by lignin or other plant macromolecules. These bound residues may still possess toxicological character and may become released on digestion of the contaminated food crops.

Pesticidal activities of secondary plant metabolites

Selected sesquiterpene lactones were shown to be of potential use as antifungal and antibacterial agents, and their activity and specificity could be further enhanced through modification in their chemical structures. Similarly, it was observed that the chemical moiety on the ring plays an important role in determining the role of sesquiterpene lactones as antibacterial agents.

Isoalantolactone, a sesquiterpene lactone from *Inula* spp., was found to reduce the germination rate of several noxious Canadian weeds such as redroot pigweed and lamb's-quarters. However, this compound was found to have stimulatory or only mild inhibitory effect on the germination of crop plants.

SOIL CHEMISTRY AND MINERALOGY

Soil carbohydrates

Glucosamine and galactosamine, important constituents of the soil nitrogen pool, were quantified by high-performance gas chromatography in four cultivated soils under grain and corn cover. Results showed in all instances a parallel between organic C, N, and amino sugar content with definite enrichment in amino sugars and organic matter content in the small particle size fractions of the soils under corn. The interaction between reducing sugars and amino compounds (Mailard reaction) as a possible mechanism for the formation of soil organic matter polymers resistant to microbes was further investigated. Products of the reaction of xylose with glycine and urea were isolated and their novel structures were determined. The importance of these compounds as possible intermediates in soil humification processes is at present being assessed.

In collaboration with the Macaulay Institute, Aberdeen, and the National Research Council, Ottawa, studies were continued on the fate in soils of ^{15}N-labeled wheat and ^{13}C- and ^{15}N-labeled fertilizers. An uneven distribution of the label in the different particle-size fractions was observed. The ^{13}C- and ^{15}N-labeled fractions were analyzed by cross-polarization magic-angle spinning (CP-MAS) NMR.

Soil nitrogen

Information on the genesis of the "unknown" soil nitrogen was obtained from a study on the N distribution in soils buried for thousands of years. With increasing age, amino acid-N and ammonia-N decreased but relative concentrations of amino sugars remained small throughout, with concentrations of galactosamine exceeding those of glucosamine. The data showed that with increasing age, identifiable N components were converted to complex polymeric compounds whose identities remain obscure. In the 6000-year-old soil, N constituted 69.4% of the total N, whereas in the 29 000-year-old soil, the proportion of "unknown" N was 89.9%.

Chemistry of humic and fulvic acids

Effects of acid hydrolysis on the chemical structure of humic and fulvic acids were assessed by comparing liquid-state ^{13}C-NMR spectra of hydrolyzed with those of unhydrolyzed humic substances. Hydrolysis with hot 6 *N* HCl was found to be more efficient for removing carbohydrates and proteinaceous materials from humic and fulvic acids than was hydrolysis with H_2SO_4. The latter, however, appeared to better preserve the structural integrity of the humic materials, especially in the lower aliphatic region (0–50 ppm). The data obtained demonstrate the potential of ^{13}C-NMR for observing effects of different agricultural practices, treatments, and seasonal variations on humic substances. Enzymatic hydrolysis of a humic acid (HA) was tested as an alternative method to hot acid hydrolysis for releasing amino-N and ammonia. Pronase, a nonspecific proteolytic enzyme, was found to efficiently deproteinate a HA extracted from a Gleysol. The efficiency of hydrolysis by the immobilized pronase remained high (80%) compared with that by acid hydrolysis. Enzymatic hydrolysis under relatively mild conditions could avoid drastic chemical modification imparted by acid hydrolysis during characterization studies of soil organic matter.

Freeze-dried metal – fulvic acid complexes were examined by scanning-transmission electron microscopy and by energy dispersive X-ray spectrometry to obtain information on the distribution of the metals. The complexing of metals by the fulvic acid did not change its physical configurations. Copper and iron elemental maps of the metal complexes showed homogenous distributions of the metals on the fulvic acid.

Acid soils

Climatic conditions generally favor an increase in soil acidity. Intensive agricultural practices, such as fertilization, irrigation, improved drainage, and no-tillage cultivation, all contribute to soil acidification. As a result, Al becomes an important exchangeable cation in these soils and its toxicity to plants becomes serious with other accompanying factors in acid soils. From an agricultural point of view, acid rain (precipitation) is an added factor to this general problem of acidity. Therefore, effects of SO_4^{2-} ions on chemical properties of soils were investigated. The results showed that the presence of these ions reduced the amount of Al^{3+} in an aqueous system by forming soluble complex $AlSO_4^+$. This process was tested on four acid soils from Quebec and British Columbia for its application to the amelioration of acid soils. The equilibration of the acid soils with $CaSO_4$ solution increased the soil pH, ion-activity product $Al(OH)_3$, and neutral salt extractable exchangeable cations. The application of gypsum to acid soils prior to liming should be effective in reduction of Al toxicity and increasing base exchange capacity.

Microbial alteration of biotite and jarosite formation

The microbial alteration of biotite was investigated in connection with formation of jarosite in soils. The *Thiobacillus ferrooxidans* bacterium was not able to oxidize a significant amount of structural Fe^{2+} of biotite, but worked indirectly to dissolve potassium from biotite interlayers. Subsequently the K dissolved reacted with Fe^{3+}, SO_4^{2-} and H_2O to form jarosite.

NH_4 and K fixation by vermiculite soil

Mineral alteration of vermiculite to mica caused by fixation of NH_4 and K was verified in a corn-cropped Mountain sandy clay loam soil at the Central Experimental Farm, Ottawa, which had received a high rate of liquid dairy manure applications during six consecutive years. Observed imbalance between amounts of N + K supplied and available to the plant can be explained by a high retention of NH_4 and K by the vermiculite soil.

Infrared spectra of soil minerals

In view of increasing necessity of a concise and comprehensive reference data source for mineral identification by infrared (IR) absorption spectra, 326 spectra were selected as standard spectra for 280 reference minerals. Silicates, oxides, hydroxides, carbonates, sulfates, and phosphates were included on the basis of their occurrence in soils or their structural similarities to the minerals occurring in soils. One of the unique features in this compilation is that IR spectra were collected for many varieties and subspecies of phyllosilicates, which constitute a majority of clay minerals in soils. The IR data source will be helpful for mineral identification and characterization.

MINERAL ANALYSES SERVICES

Twenty-five professional and technical staff from research institutes, research stations, and outside agencies made use of the services of the Centre for X-ray diffraction, infrared (IR), Mossbauer effect, and thermogravimetric analyses. The Centre produced approximately 2000 X-ray diffractograms and 300 IR spectra and contributed supportive data to at least 15 papers and reports on mineral characterization of Canadian soils, mineral weathering, and mineralogy of tar sands. The addition of a fully automated X-ray diffractometer has increased the production of diffractograms by 50% and has improved the quality of diffraction data. An improved technique for the solvation of mineral samples with glycerol facilitated the detection of smectites. A low-temperature attachment to the Mossbauer spectrometer was installed. Accordingly a new platform for radiation source and detector was designed and constructed. The platform is horizontally and vertically adjustable in order to get an optimum setting for radiation-source-sample detector (absorber) with minimum alteration of the assembly.

ANALYTICAL CHEMISTRY SERVICES

Analytical Chemistry Services continued to provide Branch establishments with analyses in support of research projects in areas of soil management and protection; land use; energy production and conservation; environmental quality; production improvement of dairy cattle and poultry; production improvement of cereal, oilseed, forage, horticultural, and field crops; food processing and new product development; and food safety. A wide range of research materials such as dietary fiber, fat, cellulose, lignin, ash, caloric value, macroelements, trace elements, nitrogen, protein, amino acids, carbohydrates, and organic functional groups were analyzed. Approximately 71 000 determinations were provided to 130 scientists and technical staff of 20 Branch institutes and stations. Priority analyses were provided regarding amino acid determinations for the mycotoxin research program.

Evaluation was completed of automated spectrophotometric and manual titrimetric methods for total and reducing sugars, with the former procedure being adopted for high-throughput routine application. A renovated nitrogen laboratory is on stream, with the bulk of the nitrogen determinations being transferred to the Technicon autoanalyzer. Acquisition and calculation of amino acid data were facilitated by interfacing a microcomputer with the amino acid analyzer.

Analysis protocols were devised for the assessment of sample homogeneity and for quantitation of elemental concentrations in agricultural reference materials. The maize reference materials recently produced are currently being analyzed by cooperating laboratories using diverse independent methodologies to establish levels of a number of macronutrient and micronutrient elements as well as elements of toxicological and environmental interest.

ELECTRON MICROSCOPE CENTRE

Seventy-two professional and technical staff of the Ottawa institutes (stations, centres), six off-campus stations, and eight outside agencies, universities, other government departments, and industry made use of the facilities of the Electron Microscope Centre. Postal Service projects were undertaken for the St. John's, Charlottetown, Saint-Jean, Harrow, and Regina research stations and the Smithfield experimental farm.

The Centre contributed significantly to 51 manuscripts and graduate dissertations concerned with methodology development, the systematics and phylogeny of insects, membrane ultrastructure related to stress, ultrastructure of blood platelets, fungal zoospores, fulvic acid – metal interactions, food microstructure, toxin effects on plants, the confirmation of virus-free potato tissue, surface textures of tobacco, fiber morphology, and the microanalyses of soils and soil complexes. Particulars of these publications appear under the individual listings of institutes and stations.

The capacity of the Centre was increased by the design and modification of a number of devices to facilitate freeze-etching of biological specimens. A special holder was fabricated for the preparation of platinum–carbon electrodes. The Kevex X-ray spectrometer was updated with the addition of a rate meter for line profiles and a scan rotation facility. Special preparatory methods were developed for the preparation of clean intact layers of chloroplasts.

The Electron Microscope Centre hosted visiting workers and graduate students from Trinidad, Iraq, USA, and the universities of Lethbridge, Miami, Carleton, Ottawa, and McGill and contributed to a number of cooperative education programs for secondary schools.

PUBLICATIONS

Research

Andrews, C. J.; Gudliefsson, B. E. 1983. A comparison of cold hardiness and ice encasement tolerance of timothy grass and winter wheat. Can. J. Plant Sci. 63:429-435.

Andrews, C. J.; Paliwal, Y. C. 1983. The influence of preinfection cold hardening and disease development period on the interaction between barley yellow dwarf virus and cold stress tolerance in wheat. Can. J. Bot. 61:1935-1940.

Andrews, C. J.; Pomeroy, M. K. 1983. Influence of flooding pretreatment on metabolic changes during ice encasement. Can. J. Bot. 61:142-147.

Andrews, C. J.; Pomeroy, M. K. 1983. Ice encasement tolerance of isolated cells from cold hardened winter wheat. Cryoletters 4:33-42.

Behki, R. M.; Selveraj, G.; Iyer, V. N. 1983. Hydrogenase and ribulose-1,5-biphosphate carboxylase activities of *Alcaligenes eutrophus* ATCC 17706 associated with an indigenous plasmid. Can. J. Microbiol. 29:767-774.

Benzing-Purdie, L.; Ripmeester, J. A. 1983. Melanoidins and soil organic matter: Evidence of strong similarities revealed by ^{13}C CP-MAS NMR. Soil Sci. Soc. Am. J. 47:56-61.

Benzing-Purdie, L.; Ripmeester, J. A.; Preston, C. M. 1983. Elucidation of the nitrogen forms in melanoidins and humic acid by nitrogen-15 cross polarization – magic angle spinning nuclear magnetic resonance spectroscopy. J. Agric. Food Chem. 31:913-915.

Bromfield, E. S. P.; Kumar Rao, J. V. D. K. 1983. Studies on fast and slow growing *Rhizobium* spp. nodulating *Cajanus cajan* and *Cicer arietinum*. Ann. Appl. Biol. 102:485-493.

Chiykowski, L. N. 1983. Frozen leafhoppers as a vehicle for long-term storage of different isolates of the aster yellows agent. Can. J. Plant Pathol. 5:101-106.

Corbin, D.; Barran, L.; Ditta, G. 1983. Organization and expression of *Rhizobium meliloti* nitrogen fixation genes. Proc. Natl. Acad. Sci. (USA) 80:3005-3009.

Fackrell, H. B.; Sinha, R. C. 1983. Serological analysis of *Pseudomonas syringae* pv. *tomato*. Phytopathology 73:178-181.

Gamble, D. S.; Khan, S. U.; Tee, O. S. 1983. Atrazine hydrolysis. Part I. Proton catalysis at 25°C. Pestic. Sci. 14:537-545.

Gamble, D. S.; Schnitzer, M.; Kerndorff, H.; Langford, C. H. 1983. Multiple ion exchange equilibria with humic acid. Geochim. Cosmochim. Acta 47:1311-1323.

Gao, J. Y.; Andrews, C. J.; Pomeroy, M. K. 1983. Interactions among flooding, freezing, and ice encasement in winter wheat. Plant Physiol. 72:303-307.

Greenhalgh, R.; Blackwell, B. A.; Preston, C. M.; Murray, W. J. 1983. 31-P Nuclear magnetic resonance analysis of technical organophosphorus insecticides for toxic contaminants. J. Agric. Food Chem. 31:710-713.

Greenhalgh, R.; Neish, G. A.; Miller, J. D. 1983. Deoxynivalenol, acetyl deoxynivalenol, and zearalenone formation by Canadian isolates of *Fusarium graminearum* on solid substrates. Appl. Environ. Microbiol. 46:625-629.

Ivan, M.; Ihnat, M.; Veira, D. M. 1983. Solubility and flow of calcium, magnesium and phosphorus in the digestive tract of sheep given maize or alfalfa silages. Anim. Feed Sci. Technol. 9:131-142.

Ivan, M.; Ihnat, M.; Veira, D. M. 1983. Flow and soluble proportions of zinc, manganese, copper and iron in the gastrointestinal tract of sheep fed corn or alfalfa silages. Can. J. Anim. Sci. 63:163-171.

Khan, S. U.; Akhtar, M. H. 1983. In vitro release of bound (nonextractable) atrazine residues from corn plants by chicken liver homogenate and bovine rumen liquor. J. Agric. Food Chem. 31:641-644.

Khan, S. U.; Akhtar, M. H. 1983. Photodecomposition of chlorothalonil in benzene. Pestic. Sci. 14:354-358.

Khan, S. U.; Gamble, D. S. 1983. UV irradiation of aqueous solution of prometryn in presence of humic materals. J. Agric. Food Chem. 31:1099-1104.

Kodama, H.; DeKimpe, C. R. 1983. Ferruginous swelling clay minerals in a gabbro saprolite from Mount Megantics. Can. J. Soil Sci. 63:143-148.

Kodama, H.; Schnitzer, M.; Jaakkimainen, M. 1983. Chlorite and biotite weathering by fulvic acid solutions in closed and open systems. Can. J. Soil Sci. 63:619-629.

Macdowall, F. D. H. 1983. Kinetics of first-cutting regrowth of alfalfa plants and nitrogenase activity in a controlled environment with and without added nitrate. Can. J. Bot. 61:2405-2409.

Macdowall, F. D. H. 1983. Effects of light intensity and CO_2 concentration on the kinetics of 1st month growth and nitrogen fixation of alfalfa. Can. J. Bot. 61:731-740.

McCoy, R. E.; Sinha, R. C. 1983. Antibiotic treatment of plants and bioassay to determine antibiotic concentration. Methods Mycoplasmol. 2:269-273.

McKeague, J. A.; Grant, D. R.; Kodama, H.; Beke, G. J.; Wang, C. 1983. Properties and genesis of a soil and the underlying gibbsite-bearing saprolite, Cape Breton Island, Canada. Can. J. Earth Sci. 20:37-48.

Miller, J. D.; Jones, E. B. G. 1983. Observations on the association of thraustochytrid marine fungi with decaying seaweed. Bot. Mar. 26:345-351.

Miller, R. W.; Sirois, J. C. 1983. Calcium and magnesium effects of symbiotic nitrogen fixation in the alfalfa – *Rhizobium meliloti* system. Physiol. Plant. 58:464-470.

Miller, J. D.; Taylor, A.; Greenhalgh, R. 1983. Production of deoxynivalenol and related compounds in liquid culture by *Fusarium graminearum*. Can. J. Microbiol. 29:1171-1178.

Miller, R. W.; Tremblay, P. A. 1983. Cytoplasmic membrane of *Rhizobium meliloti* bacteroids (I). Can. J. Biochem. Cell Biol. 61:1334-1339.

Miller, J. D.; Whitney, N. J. 1983. Fungi of the Bay of Fundy V: Fungi from living species of *Spartina* Schreber. Proc. Nova Scotia Inst. Sci. 33:75-83.

Miller, J. D.; Young, J. C.; Trenholm, H. L. 1983. *Fusarium* toxins in field corn. I. Time course of fungal growth and production of deoxynivalenol and other mycotoxins. Can. J. Bot. 61:3080-3087.

Neish, G. A.; Farnworth, E. R.; Greenhalgh, R.; Young, J. C. 1983. Observations on the occurrence of *Fusarium* species and their toxins in corn in Eastern Ontario. Can. J. Plant Pathol. 5:11-16.

Paliwal, Y. C. 1983. Identification and distribution in Eastern Canada of lucerne transient streak, a virus newly recognized in North America. Can. J. Plant Pathol. 5:75-80.

Peterson, E. A.; Sirois, J. C.; Berndt, W. B.; Miller, R. W. 1983. Evaluation of competitive ability of *Rhizobium meliloti* strains for nodulation in alfalfa. Can. J. Microbiol. 29:541-545.

Picman, A. K. 1983. Antifungal activity of helenin and isohelenin. Biochem. Syst. Ecol. 11:183-186.

Picman, A. K.; Towers, G. H. N. 1983. Antibacterial activity of sesquiterpene lactones. Biochem. Syst. Ecol. 11:321-327.

Pomeroy, M. K.; Pihakaski, S. J.; Andrews, C. J. 1983. Membrane properties of isolated winter wheat cells in relation to icing stress. Plant Physiol. 72:535-539.

Preston, C. M.; Ripmeester, J. A. 1983. ^{13}C labelling for NMR studies of soils: CP-MAS NMR observation of ^{13}C-acetate transformation in a mineral soil. Can. J. Soil Sci. 63:495-500.

Ross, G. J.; Kodama, H.; Wang, C.; Gray, J. T.; Lafreniere, L. B. 1983. Halloysite from a strongly weathered soil at Mont Jacques Cartier, Québec. Soil Sci. Soc. Am. J. 47:327-332.

Schnitzer, M. 1983. Organic matter characterization. Pages 581-594 *in* Page, A. L., ed. Methods of soil analysis, part 2. American Society of Agronomy, Madison, Wisconsin.

Schnitzer, M.; Ivarson, K. C. 1983. Different forms of nitrogen in particle size fractions separated from two soils. Plant Soil 69:383-389.

Schneider, H.; Maleszka, R.; Neirinck, L.; Veliky, I. A.; Wang, P. Y.; Chan, Y. K. 1983. Ethanol production from D-xylose and several other carbohydrates by *Pachysolen tannophilus* and other yeasts. Pages 57-71 *in* Fiechter, A.; Jeffries, T. W., eds. Pentoses and lignin. Advances in biochemical engineering/biotechnology, no. 27. Springer-Verlag, Berlin.

Schnitzer, M.; Marshall, P. R.; Hindle, D. A. 1983. The isolation of soil humic and fulvic acid components rich in "unknown" nitrogen. Can. J. Soil Sci. 63:425-433.

Schuppli, P. A.; Ross, G. J.; McKeague, J. A. 1983. The effective removal of suspended materials from pyrophosphate extracts of soils from tropical and temperate regions. Soil Sci. Soc. Am. J. 47:1026-1032.

Scott, P. M.; Kannere, S. R.; Lau, P. Y.; Dexter, J. E.; Greenhalgh, R. 1983. Effects of experimental flour milling and bread baking on retention of deoxynivalenol (vomitoxin) in hard red spring wheat. Cereal Chem. 60:421-424.

Siminovitch, D.; Cloutier, Y. 1983. Drought and freezing tolerance and adaptation in plants: Some evidence of near equivalences. Cryobiology 20:487-503.

Sinha, R. C. 1983. Relative concentration of mycoplasma-like organisms in plants at various times after infection with aster yellows. Can. J. Plant Pathol. 5:5-10.

Sinha, R. C. 1983. Physical techniques for purification of mycoplasmas from plant tissues. Methods Mycoplasmol. 2:243-247.

Sinha, R. C.; Benhamou, N. 1983. Detection of mycoplasma-like organism-antigens from aster yellows diseased plants by two serological procedures. Phytopathology 73:1199-1202.

Spiteller, M.; Schnitzer, M. 1983. A comparison of the structural characteristics of polymaleic acid and a soil fulvic acid. J. Soil Sci. 34:525-537.

Watson, R.; Konarska-Kozlowska, M.; Iyer, V. N.; Yaguchi, M.; Visentin, L. P. 1983. Comparison of plasmids ColE2-P9 and ColE2-CA42 and their immunity proteins. J. Bacteriol. 153:1552-1557.

Weinberger, P.; Greenhalgh, R.; Sher, D.; Dulett, M. 1982. Persistence of formulated fenitrothion in distilled estuarine and lake water in dynamic systems. Bull. Environ. Contam. Toxicol. 28:486-489.

Weinberger, P.; Sher, D.; Greenhalgh, R. 1983. Interaction between co-solvents and algae in the residue dynamics of fenitrothion. J. Environ. Sci. Health B 18:269-281.

Zhang, L.; Akhtar, M. H.; Khan, S. U. 1983. Reaction of diazomethane with chlorothalonil. Chemosphere 12:951-954.

Miscellaneous

Franklin, C. A.; Greenhalgh, R.; Maibach, H. I. 1983. Correlation of urinary dialky phosphate metabolites with dermal exposure to azinphos-methyl. Proceeding of the 5th IUPAC International Congress of Pesticide Chemistry, Kyoto, Japan. Greenhalgh, R.; Drescher, N., eds. Pergamon Press, Oxford, England. pp. 221-226.

Greenhalgh, R.; Drescher, N., eds. 1983. Pesticide chemistry Human welfare and the environment. Vol. IV, 429 pp. Pesticide residues and formulation chemistry. Pergamon Press, Oxford.

Kodama, H. 1983. Book review: Clay minerals, by Erno Nemecz. Can. Mineral. 21:162-163.

McKeague, J. A.; Kodama, H.; Schuppli, P. A.; Tarnocai, C. 1982. Some applications of SEM-EDXRA to soil genesis research. Proc. 19th Annual Microscopy Colloquium. pp. 10-11.

Moody, R. P.; Weinberger, P.; Greenhalgh, R. 1983. Algal fluorimetric determination of the potential phytotoxicity of environmental pollutants. Aquatic toxicology. Nriagu, J. O., ed. Wiley and Sons, New York, USA. pp. 503-512.

Pomeroy, M. K.; Andrews, C. J. 1983. Responses of winter cereals to various low temperature stresses. Vol. 2, Pages 96-106. Randall, D. D.; Blevins, D. G.; Larson, R. L.; Rapp, B. J., eds. *in* Current topics in plant biochemistry and physiology. University of Missouri Press, Missouri, USA.

Pomeroy, M. K.; Andrews, C. J. 1983. Flooding and ice encasement damage to winter wheat. Pages 39-56. Fowler, D. B.; Gusta, L. V.; Slinkard, A. E.; Hobin, B. A., eds. *in* New frontiers in winter wheat production. University of Saskatchewan Printing Services, Canada.

Weinberger, P.; Greenhalgh, R. 1983. Review of ecotoxicity of matacil in freshwater environment: Chemical and phytobiological impact studies. Aquatic toxicology. Nriagu, J. O., ed. Wiley and Sons, New York, USA. pp. 437-448.

Engineering and Statistical Research Institute

Ottawa, Ontario

PROFESSIONAL STAFF

P. W. Voisey, F.I., Mech.E.	Director
H. Pitt, B.A.	Administration

Energy

P. Van Die, B.Sc. (Eng.), M.Sc.	Head of Section; Energy
D. LeBlanc, B.Sc. (Eng.)	Processing, distributing, retailing
M. Levesque, B.Sc. (Eng.)	Conservation—buildings
H. A. Jackson, B.Sc. (Eng.), M.Sc.	Greenhouses and solar
E. Manolakis, B.Sc.	Liquid fuels
D. Marshall, B.Sc. (Eng.)	Biomass and conservation—mechanization
D. Sidaway-Wolf, B.Sc.	Processing, distributing, retailing
C. Vigneault, B.Sc.	Mechanization—fertilizer

Food Engineering

G. E. Timbers, B.S.A., M.S.A., Ph.D.	Head of Section; Food process engineering
D. McGinnis, B.Ap.Sc. (Eng.), M.Sc.	Food process engineering

Research Service

E. J. Brach, D.E.E., Dip.Mil.	Head of Section; Electronics
D. J. Buckley, B.E., M.Sc.	Electronics

Structures and Mechanization

M. Feldman, B.E., M.Sc.	Head of Section; Mechanization, Manager of ERDAF contract program

L. P. Heslop, B.Sc.	Mechanization
K. W. Lievers, B.Sc. (Agr.), M.Sc.	Systems analysis
D. Massé, B.Sc.	Canada Plan Service Design Engineer
J. A. Munroe, B.S.A., M.Sc., Ph.D.	Structures
P. A. Phillips, B.Sc. (Agr.), M.Sc., Ph.D.	Animal environment
W. S. Reid, B.Sc. (Agr.), M.Sc.	Mechanization
J. E. Turnbull, B.S.A., M.S.A.	Director, Canada Plan Service; Farm structures

Statistical Research

G. P. Poushinsky, B.Sc., M.Sc.	Head of Section; Statistics
M. R. Binns, M.A., Dip.Math.Stat.	Statistics
G. Butler, B.Math., M.Math.	Statistics
P. Y. Jui, B.Sc., M.Sc., Ph.D.	Statistics
L. P. Lefkovitch, B.Sc.	Statistics
C. S. Lin, B.Sc., M.Sc., Ph.D.	Statistics
B. K. Thompson, B.Sc., M.Math, Ph.D.	Statistics
C. J. Williams, B.S.A., M.Sc., Ph.D.	Statistics
M. S. Wolynetz, B.Math., M.Math., Ph.D.	Statistics

W. Watt, B.A.	Head, Systems and programming
I. Hall, Cert.Info.Proc.	Systems and programming
K. Heng, B.Sc., M.App.Sc.	Systems and programming
J. D. Hobbs, B.Sc.	Systems and programming

Technical Services

J. G. Caron	Head of Section

Departures

K. B. Mitchell Deceased 13 July 1983	Administration
P. M. Morse, M.A. Retired 30 November 1983	Statistics
R. Ciok, B.Sc. Resigned 25 November 1983	Statistics

VISITING SCIENTISTS

C. G. E. Downing, B.E., M.Sc., D.Sc., F.A.S.A.E., F.E.I.C., F.C.S.A.E. F.A.I.C.	Former Director, Engineering Research Service; Retired April 1977
G. L. Calver, B.A.Sc.	Consultant

INTRODUCTION

The research and support services of the Engineering and Statistics Research Institute (ESRI) were involved in 203 projects and 90 contracts.

Energy research and development (R & D) remains a primary thrust directed to the development of new technology for energy conservation and production across the Agrifood system. Notable achievements were improved systems for biogas production and a system to test the efficiency of tractor implements.

Food engineering developments for both process equipment and instruments for measuring quality continue their successful progression to commercial deployment via patents and licenses.

Support of Branch programs through the development of research instruments and apparatus continued to have a significant impact. Notable was the development of a low-cost system for recording distributed events, which will also have wide commercial applications. The field spectroscopy – remote sensing program is now being phased out in order to focus on automation of food-product grading and inspection.

The Institute's biometricians collaborated in a wide range of Branch research activities providing efficient experimental designs and comprehensive data analysis. Statistical software was enhanced and made widely accessible via the Departmental network Agrinet. A statistical training package was developed for scientists and support staff and presented to several research stations across Canada. The objective of this ongoing project is to improve statistical capabilities across the Branch.

The mechanization program continued its focus on the difficult area of mechanizing horticultural crops to enhance the prospects for import replacements. The development of a new strawberry-harvesting system is an example of how underwriting the risk of machinery development is necessary to achieve the economic potential of producing such crops. The Canada Plan Service continued its successful operation with significant provincial input to provide engineered building designs to Canadian farmers. A major achievement was the revision of the Canada Farm Building Code.

Work of the Institute was presented in 99 papers and technical reports, bringing the total body of such information to 1300 publications. The following report summarizes highlights of the 1983 achievements. Much of the engineering R & D is contracted out and a data base of this information has been established. Reprints of research publications and copies of this report are available from the Engineering and Statistical Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

P. W. Voisey
Director

ENERGY

A prototype facility to produce ice by freezing a film of water using winter coldness was further modified and the system was optimized. A full-scale unit at a commercial vegetable-storage facility was built, where the ice was used to precool the vegetables replacing mechanical refrigeration.

The microprocessor that was installed in a calf barn to control ventilation and heating demonstrated that consolidating several independent controls and using one sensor simplifies the control operation and allows more precise environment control. Although no large energy saving was found, simplifying the operation control and reducing thermostat variance gives more effective use of energy used in ventilation, particularly for systems that are not well maintained.

A low-temperature cooker developed under an ERDAF (energy research and development in agriculture and food) contract has been calibrated for further analysis of the microbiological and organoleptic aspects of cooking meat at home in the 60–75°C range. A comparison of the energy requirements for heating retort pouches at home in boiling water according to the package instructions versus heating the contents directly in a pot was made for several products.

A system for acquiring data on tractors was expanded to include a means for the measurement of axle torque, and the draft sensors were improved. The system was used to measure the power requirements of several manure land applicators. The methane digesters are demonstrating that a single-cell protein can be recovered and fed to livestock as a supplemental protein. This development dramatically improves the economics of the technology, making it appear viable for large enterprises. A plastic, light-weight, low-cost fixed-film material has been developed and was installed in several digesters. Canada is now evolving as a world leader in digester technology. Further improvements in the apparatus, allowing carbon dioxide to be scrubbed from the digester biogas, has resulted in an increase in the concentration of methane gas from 60% to 75%. This makes the gas more suitable for generating electricity by combustion. The operation of one of the first farm-scale digesters in Canada continues to provide information on the problem of solids separating out and the accumulation of hog hair hampering the performance of equipment.

The exploratory work on Jerusalem artichoke, chicory, and fodder beets as energy feedstocks was continued. Field cropping practices and the recovery and analyses of fermentable components were the major emphasis. Testing of grain cooling as a preserving and drying technique was continued. This year's data were added to the project in which the long-term potential of the ground to supply and absorb heat for ventilation air in farm applications was assessed.

Support material was prepared for the Department's participation in the national energy program. An annual budget of $7.5 million was planned. The program is predominantly contracted out and comprises over 140 contracts, half of which are directly managed by ESRI. A special meeting of 20 energy specialists from the Branch was held in Swift Current to review progress of the program for contracting out energy research and to prepare a new request for proposals. Advice on other energy projects submitted to other government departments was provided throughout the year.

FOOD ENGINEERING

A U.S. patent was granted and the Canadian patent was allowed on the blancher developed by Agriculture Canada – Atlantic Bridge Company (ABCO). World-wide marketing of the unit is being actively pursued by the Food Machinery Corporation (FMC).

Experimental determination of the surface heat transfer coefficients for processing food in retort pouches is continuing in air-over-water retorts. Work continues with the Canadian General Standards Board (CGSB) to develop processing protocols for processing food in retort pouches.

Further experimental trials with yeast-contaminated yellow mustard confirmed that *Nematospora* at levels of 105^5 organisms per gram of seed was effectively destroyed by microwave heating. At 4% moisture, heating to 100°C was necessary, but at 6% or 8% moisture heating to 80°C effectively eliminated the contamination (less than 100 organisms per gram after treatment).

Considerable progress has been made toward the commercial manufacture of the Ottawa starch viscometer developed at ESRI. This is now in the hands of industry and the first commercial units should be manufactured in the near future.

The patented "cryogran" process has again been licensed by Canadian Patents and Development Ltd (CP & DL) and a test-marketing and production agreement was signed with a commercial producer of frozen egg products.

A prototype for a condensing (heat pump) drier was constructed for trials with locally grown herbs. Design modifications have been made based on 1983 tests and further trials will be conducted in 1984.

A prototype of a hand-held device for the measurement of fish firmness was developed. This device is now being tested in Newfoundland. If it proves successful, the device will be a part of the fish quality assurance program.

CP & DL are pursuing patenting of the continuous process for separation and concentration of porcine immunogamma globulin.

Research is continuing with work on liquid cyclones and membrane separation processes.

RESEARCH SERVICE

The design and development of instruments and equipment to support research operations across the Branch continued, and a range of equipment was produced for use in both research and regulatory work of the Department.

The plot equipment developed included cereal and forage crop seeders for variety control testing.

Various mechanical equipment included a metric egg-air-cell gauge, a soil tension table and core sampler, a sow-milking machine, a freeze etch micromanipulator, a controlled-environment micromanipulator cabinet for DNA-transfer experiments, an automatic feed dispenser for individual sheep, a continuous light-intensity recorder for growth chambers, and an automatic device to measure the weight loss of a potted corn plant. A system for data acquisition and food-texture analysis was developed using a personal computer. The system eliminates the time-consuming manual measurements required with conventional methods. A number of interfaces were developed for connecting laboratory instruments to computers or to computer-compatible recorders.

A low-cost system for monitoring distributed events was developed. The system uses a single two-wire cable to monitor over 1000 widely dispersed points. Experiments that were previously too costly to perform, such as recording the time of oviposition in poultry experiments, are now feasible with the new system.

A microcomputer-based linearizer for high-speed, analog flow control valves was developed for use in an air-sampling system.

Using field spectroscopy techniques, protein and moisture measurements were achieved on standing crops at their various growth stages.

A new program has been initiated to develop methods for the inspection and grading of agricultural products by machine vision. Hand-held and automatic equipment will be developed for grading and inspecting various agricultural commodities, such as meat, eggs, cabbage, tomatoes, plums, peaches, apples, and green peppers, by their color composition.

STRUCTURES AND MECHANIZATION

Structures

The Canada Plan Service (CPS) completed 18 plan sets in 7 building categories and produced 33 leaflets. Emphasis was on swine housing and beef-handling facilities. Plans for roof trusses are being revised bas on data from truss tests, to achieve construction economies while maintaining structural safety.

Utilizing the CPS truss testing facility, four gable trusses were tested for a contractor. Truss failures occurred at 1.74 times the design load. Since this was less than the Canada Farm Building Code requirements, design improvements were suggested. Eight CPS gable truss plans were revised based on the previous test results. To further investigate load-sharing, single-member trusses were tested, but these failed at a higher load than the double-member trusses. This finding showed that a problem exists with the new plywood gussets, but this problem prevented researchers from obtaining conclusions regarding assessment of load sharing. Four doubled, single-sloped, CPS truss plans were revised and reissued.

Input continued to be made on standards and codes committees. The Canada Farm Building Code (1983) Committee received the English version of the Code. The French version is in preparation. The spiral nail design loads proposed were accepted by the CSA Committee on Wood Design. New codes are in preparation.

The contract work on silo coatings was completed successfully. Plans are to undertake longer-term observations of the coatings. A two-tiered pig pen was built for an experiment carried out with the Animal Research Centre. Initial findings are that this concept may be an improvement for swine production, by providing the animals with more space within a given barn floor space.

Field tests were carried out for the 3rd year on full-scale, earth-lined manure storages, and for the 2nd yr on small-scale storages. Some nutrient increases were found in the groundwater. Data collection continued during the winter of 1982–1983 on the roof snow-load study, and a fifth site was instrumented and added to this long-term survey to develop better design-load information.

Mechanization

Stalk-cut tobacco mechanization equipment has been satisfactorily developed and transferred to the Harrow Research Station. Test plantings and field studies with aromatic herbs were done. Harvesting parameters and problems in production were identified. Field tests were carried out with the cauliflower leaf tyer, and required modifications were made. The rhubarb harvester was modified to achieve some reduction of crop losses, but loss and damage were still too high.

The strawberry harvester prototype was modified and tested in a solid-set crop. The associated de-capping line was delivered, installed, and tested in the cooperating processing plant. Data were collected and excellent cooperation between the parties was achieved. For cucumbers, further ideas were tried out in the development of both the multi-pick and the once-over mechanical harvesters. Information was gathered, but further development work is required.

Evaluation of a belt crop dryer was completed, by which drying parameters were quantified and deficiencies in the dryer design were determined. The manufacturer has made some modifications as a result. Data were collected, computer models were adapted, and analysis was carried out to compare the cost of agricultural machinery with its productive worth. Information retrieval systems were updated by entry of papers published by the Canadian and American societies of agricultural engineers (CSAE and ASAE), contract reports prepared in support of the programs for agricultural engineering research and development (AERD) and ERDAF, and other selected papers. Requests for information were handled on demand, and two reports listing contract reports and ESRI publications were made available.

Work on a definition of the role of systems analysis was satisfactorily completed. A report prepared on the activities of the U.S. Department of Agriculture was submitted to the Tetrapartite Research Committee. A mechanized dairy manure-costing program was tested nationally with extension engineers, who suggested useful changes.

STATISTICAL RESEARCH

The statistics group continued to provide support to all Branch objectives by designing and analyzing experiments, by training Branch researchers in statistics, by maintaining and enhancing computer software, and by doing research in areas lacking adequate statistical techniques.

Major collaborative efforts have taken place with scientists from across Canada dealing with the mycotoxin program; with assessment of the bioactivity and synergistic effects of fumigants, insecticides, and herbicides; with safe blood levels of chemicals and minerals; and with quality assurance of chemical analyses and interlaboratory collaborative trials. The breeding programs for barley, oats, corn, potatoes, wheat, canola, and tobacco were supported through statistical input in design and analysis; and several new techniques have been introduced to reduce the requirements for replication, to improve the accuracy of estimates through the use of nearest-neighbor analyses, and to improve the precision of cooperative trials. The problem of genotype × environment interaction is being investigated from several viewpoints and general methodology has been made available. The eggshell and animal feedstuffs programs are receiving significant support; in addition, statisticians are aiding the swine, poultry breeding, beef, and sheep programs. Consultation and experimental design are being provided to the food quality program, with major support going to the sensory evaluation of foods. Statistical research is on going in bioassay, the theory and application of clustering, magnitude estimation as a technique in food research, nearest-neighbor methods for improved precision in field experiments, and new designs for special purposes.

The analysis of data has been facilitated by enhancing the computer programs available on AgriNet and Datacrown and through the provision of basic statistical training at some 20 Research Branch establishments. The programs provided by the Statistical Research Section were run about 24 000 times during the year. New software is being evaluated for the Department for statistical analysis and pictorial representation of data.

TECHNICAL SERVICES

Services were provided to all Branches on the Ottawa Campus to install, maintain, and modify scientific equipment for establishments. The preventative maintenance program was expanded. However, reductions in shop manpower necessitated the withdrawal of machine shop fabrication services, the work being directed to local machine shops.

PUBLICATIONS

Research

Binns, M. R.; Morse, P. M.; Thompson, B. K. 1983. Letter to the editor: "Analysis of combined experiments", by M. S. McIntosh. Agron. J. 75:1056-1057.

Binns, M. R.; Ogilvie, I.; Arnold, N.; Lukosevicius, P. 1983. Size of plots and blocks in agricultural experiments: An empirical study with cigar-filler tobacco. Indian J. Agric. Sci. 53:706-712.

Brach, E. J. 1983. Field spectroscopy in the food production chain. Food Microstruct. 2:67-80.

Brach, E. J.; Poirier, P.; Desjardins, R. L.; Lord, D. 1983. Multispectral radiometer to measure crop canopy characteristics. Rev. Sci. Instrum. 54:493-500.

Buckley, D. J.; St-Amour, G. R.; Nicholls, C. F.; DiMenna, N. 1983. A four-channel counting system for seed vigor analysis and other applications. Hortscience 18:429-430.

Court, W. A.; Binns, M. R.; Hendel, J. G. 1983. Examination of the influence of curing and stalk position on the phenolic compounds of flue-cured tobacco. Tob. Sci. 27:51-55.

Farnworth, E. R.; Hamilton, R. M. G.; Thompson, B. K.; Trenholm, H. L. 1983. Liver lipid levels in white leghorn hen fed diets that contained wheat contaminated by deoxynivalenol (vomitoxin). Poult. Sci. 62:832-836.

Farnworth, E. R.; Kramer, J. K. G.; Corner, A. H.; Thompson, B. K. 1983. The methionine and choline status of rat diets and their effects on nutrition and myocardial lesions. J. Nutr. 113:2442-2454.

Farnworth, E. R.; Kramer, J. K. G.; Jones, J. D.; Thompson, B. K.; Corner, A. H. 1983. The effect of commercial processing on the nutritional and cardiopathological quality of low erucic acid rapeseed oil. Can. Inst. Food Sci. Technol. J. 16:111-115.

Friend, D. W.; Trenholm, H. L.; Fiser, P. S.; Thompson, B. K.; Hartin, K. E. 1983. Effect on dam performance and fetal development of deoxynivalenol (vomitoxin) contaminated wheat in the diet of pregnant gilts. Can. J. Anim. Sci. 63:689-698.

Grunder, A. A.; Lefkovitch, L. P.; Chambers, J. R.; Gavora, J. S. 1983. Blood plasma and production traits in commercial broiler parent stocks. Can. J. Anim. Sci. 63:247-250.

Harcourt, D. G.; Binns, M. R.; Guppy, J. C. 1983. Sample size determination for *Hypera postica* (Coleoptera: Curculionidae) adults: A comparison of two methods. Environ. Entomol. 12:1623-1627.

Hergert, G. B. 1983. Production techniques for baby carrots and small red beets. Can. Agric. Eng. 25:33-38.

Hergert, G. B.; Compton, B. A.; Rayment, A. F 1983. A tractor for agricultural development of peat soils. Can. Agric. Eng. 25:39-46.

Hidiroglou, M.; Thompson, B. K. 1983. The effect of turn-out to pasture on blood plasma iron concentrations in beef cattle. Livestock Prod. Sci. 10:83-87.

Holley, R. A.; Timbers, G. E. 1983. *Nematospora* destruction in mustard seed by microwave and moisture treatments. Can. Inst. Food Sci. Technol. J. 16:68-75.

Lin, C. S.; Poushinsky, G. P. 1983. A modified augmented design for an early stage of plant selection involving a large number of test lines without replication. Biometrics 39:553-561.

Lin, C. S.; Poushinsky, G. P.; Jui, P. Y. 1983. Simulation study of three adjustment methods for the modified design and comparison with the balanced lattice square design. J. Agric. Sci. 100:527-534.

Massé, D. I.; Turnbull, J. E.; Williams, C. J. 1983. Screwed connections for corrugated steel diaphragm ceilings in farm buildings. Can. Agric. Eng. 25:95-100.

McGinnis, D. S.; Ogilvie, J. R.; Pattie, D. R.; Blenkhorn, K. W.; Turnbull, J. E. 1983. Shell-and-tube heat exchange for swine buildings. Can. Agric. Eng. 25:69-74.

McGinnis, D. S.; Sidaway-Wolf, D. 1983. Retort pouch technology. Can. Inst. Food Sci. Technol. J. 4:6-10.

Modler, H. W.; Larmond, E.: Lin, C. S.; Froehlich, D.; Emmons, D. B. 1983. Physical and sensory properties of yogurt stabilized with milk proteins. J. Dairy Sci. 66:422-429.

Munroe, J. A.; Winfield, R. G. 1983. Performance of a solar collector/storage wall for preheating ventilation air in a swine barn. Can. Agric. Eng. 25:63-69.

Pandeya, R. S.; Dirks, V. A. L.; Poushinsky, G. P. 1983. Quantitative genetic studies in flue-cured tobacco (*Nicotiana tabacum*). I. Agronomic characters. Can. J. Genet. Cytol. 25:336-345.

Phillips, P. A. 1983. Manure application rate based on running average manure analysis values. Can. Agric. Eng. 25:57-58.

Phillips, P. A.; MacHardy, F. V. 1983. Predicting heat production in young calves housed at low temperatures. Trans. Am. Soc. Agric. Eng. (ASAE) 26:175-178.

Reid, W. S.; Buckley, D. J.; Downey, R. K. 1983. A semiautomatic seed counter. J. Agric. Eng. Res. 28:89-95.

Reid, W. S.; Ivan, M.; Buckley, D. J. 1983. An automatic digesta sampler for sheep. J. Agric. Eng. Res. 28:79-87.

Reid, W. S.; Liptay, A.; Nicholls, C. F.; Marriage, P. B. 1983. A plug-mix planter attachment for dispensing a charcoal–vermiculite mixture to protect emerging seedlings from herbicide toxicity. Can. J. Plant Sci. 63:567-571.

Sampson, D. R.; Flynn, D. W.; Jui, P. Y. 1983. Inheritance of kernel protein content in five spring wheat crosses. Can. J. Genet. Cytol. 25:398-402.

Sampson, D. R.; Flynn, D. W.; Jui, P. Y. 1983. Genetic studies on kernel hardness in wheat using grinding time and near infrared reflectance spectroscopy. Can. J. Plant Sci. 63:825-832.

Sibbald, I. R.; Morse, P. M. 1983. Effects of the nitrogen correction and of feed intake on true metabolizable energy values. Poult. Sci. 62:138-142.

Sibbald, I. R.; Morse, P. M. 1983. The effects of feed input and excreta collection time on estimates of metabolic plus endogenous energy losses in the bioassay for true metabolizable energy. Poult. Sci. 62:68-76.

Sibbald, I. R.; Morse, P. M. 1983. Provision of supplemental feed and the application of a nitrogen correction in bioassays for true metabolizable energy. Poult. Sci. 62:1587-1605.

Stemshorn, R. W.; Buckley, D. J.; St-Amour, G. R.; Lin, C. S.; Duncan, J. R. 1983. A computer-interfaced photometer and systematic spacing of duplicates to control within-plate enzyme-immunoassay variation. J. Immunol. Methods 61:367-375.

Thompson, B. K.; Grunder, A. A.; Hamilton, R. M. G.; Hollands, K. G. 1983. Repeatability of egg shell quality measurement within individual hens. Poult. Sci. 62:2309-2314.

Thompson, B. K.; Williams, C. J.; Wolynetz, M. S. 1983. Some difficulties of interpreting multislope analysis of covariance from statistical computer packages. J. Dairy Sci. 66:1189-1197.

Timbers, G. E.; Wyslouzil, W.; Kashyap, S. C. 1982. Inactivation of myrosinase enzyme in mustard seed by microwave heating. Microwave Power 71:324-325.

Topp, G. C.; Sattlecker, S. 1983. A rapid measurement of horizontal and vertical components of saturated hydraulic conductivity. Can. Agric. Eng. 25:193-198.

Trenholm, H. L.; Cochrane, W. P.; Cohen, H.; Elliot, J. I.; Thompson, B. K. 1983. Survey of vomitoxin contamination of the 1980 Ontario white winter wheat crop: Results of survey and feeding trials. J. Assoc. Off. Anal. Chem. 66:92-97.

Turnbull, J. E. 1983. A summary of diaphragm design for wind bracing in stud-wall farm buildings. Trans. Am. Soc. Agric. Eng. (ASAE) 26:549-556, 561.

Turnbull, J. E.; Massé, D. I.; Buckley, D. J. 1983. First experiences with a new facility for testing wood-framed roof trusses, diaphragms and rigid frames. Can. Agric. Eng. 25:101-110.

Veira, D. M.; Fortin, A.; Ivan, M.; Butler, G.; Proulx, J. G. 1983. Performance of Hereford × Shorthorn bulls and steers raised in northern Ontario and fed different levels of grass silage and high moisture barley. Can. J. Anim. Sci. 63:861-869.

Veira, D. M.; Ivan, M.; Jui, P. Y. 1983. Rumen ciliate protozoa: Effects on digestion in the stomach of sheep. J. Dairy Sci. 66:1015-1022.

Wolynetz, M. S.; Binns, M. R. 1983. Stability of dairy cattle: Models with censoring and covariates. J. Dairy Sci. 66:935-942.

Miscellaneous

Binns, M. R.; Basrur, P. K.; Zilkey, B.; Court, W. A.; Pandeya, R. S. 1983. Comparative mutagenic assay of cigarette smoke condensates: An evaluation based on Canadian experimental cigarettes/Essai comparatif de mutagénicite des condensats de fumée de cigarettes: Evaluation basée sur des cigarettes expérimentales d'origine canadienne. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. 8038-1518. 40 pp. (July).

Brach, E. J.; Simmons, J.; Poirier, P. 1983. Wavelength programmable spectrophotometer for individual plant studies. Proc. of Los Alamos Conference on Optics. 380:70-76 (April).

Buckley, D. J.; Hamilton, R. M. G.; St-Amour, G. R.; Fagan, W. E. 1983. A microcomputer-based distributed event monitoring system. Proc. of the Institute of Electrical and Electronics Engineers IECON. Annual Conference on Industrial Electronics. pp. 49-51 (November).

Downing, C. G. E.; Powrie, W. D., eds. 1983. Strategy for energy research, development and demonstration in the agriculture and food system/La stratégie de recherche, de développement et de démonstration sur l'utilisation de l'énergie dans le système agro-alimentaire. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. I526. 188 pp. (August).

Farnworth, E. R.; Kramer, J. K. G.; Corner, A. H.; Thompson, B. K. 1983. The methionine and choline status of diets used in rapeseed oil feeding trials. Proc. of the 6th International Rapeseed Conference, Paris. pp. 1710-1714.

Hamilton, R. M. G.; Trenholm, H. L.; Thompson, B. K. 1983. Effects of feeding chicks and laying hens diets that contain vomitoxin (deoxynivalenol) contaminated wheat. Proc. of the 19th Nutrition Conference for Feed Manufacturers. pp. 48-55 (April).

Hergert, G. B.; Smits, N.; Vigier, B.; Theriault, R.; Warren, F. S. 1983. Effect of packing and seeder-type on emergence and yield of soybeans and processing peas. Can. Soc. Agric. Eng. (CSAE) Annual Meeting, Paper No. 83-104 (July).

Hocking, R. P.; Jahn, W., eds. 1983. ESRI safety manual. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. I486. 44 pp. (October).

Kramer, J. K. G.; Farnworth, E. R.; Thompson, B. K.; Corner, A. H. 1983. Cardiac lipid changes in rats and how these correlate to myocardial necrosis. Proc. of the 6th International Rapeseed Conference, Paris. pp. 1672-1677 (May).

LeBlanc, D. 1983. Energy conservation research and development in food processing supported by Agriculture Canada. Proceedings of the International Development Research Center. International Union of Food Science and Technology Joint Seminar on Energy Conservation in Food Industries, Ottawa. *In* Report of a seminar on energy conservation in food processing industries. Report No. IDRC-MR70e. International Development Research Centre, Ottawa. pp. 46-56 (January).

Levesque, M. P.; Sullivan, G. R.; Jacobson, B. A.; Rhodes, E.; Forbes, F. 1983. Development of computer control technologies for conventional grain drying systems. Can. Soc. Agric. Eng. (CSAE) Annual Meeting, Paper No. 83-203 (July).

Levesque, M. P.; Turnbull, J. E.; Hocking, R. P. 1983. Testing a solid-state ventilation and heating controller with humidistat control in a modern calf barn. Can. Soc. Agric. Eng. (CSAE) Annual Meeting, Paper No. 83-419 (July).

Lievers, K. W. 1983. Process-level modelling activity in USDA agricultural research/Activité de modélisation au niveau des processus, liée a la recherche agricole au Ministére de l'agriculture des Etats-Unis. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. 8137-I507. 39 pp. (June).

Lord, D.; Dube, P. A.; Desjardins, R. L.; Brach, E. J. 1983. Variabilité introduite dans des mesures de reflectances spectrales de couverts végétaux agricoles par les facteurs état du ciel et vent/Variability introduced in plant canopy spectral reflectance measurement by the factors sky conditions and wind. Proc. Int. Colloquium on Spectral Signatures of Objects in Remote Sensing, Bordeaux, France. (September).

Mes-Hartree, M.; Hogan, C.; Hayes, R. D.; Saddler, J. N. 1983. Enzymatic hydrolysis of agricultural residues by trichoderma cellulases and fermentation of the liberated sugars to ethanol. Biotechnol. Lett. 4 (February).

Morrison, B. A.; Thuns, A. 1983. Energy reports (contributions) published by ESRI from 1973 to May 1983/Rapports concernant l'énergie (communication) publié par IRTS de 1973 à mai 1983. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. I501. 32 pp. (May).

Patni, N. R.; Jui, P. Y. 1983. Changes in nitrogen content of dairy cattle liquid manure during anaerobic storage. Can. Soc. Agric. Eng. (CSAE) Annual Meeting, Paper No. 83-409 (July).

Phillips, P. A.; Culley, J. L. B.; Leclerc, J. M. 1983. Groundwater from earthen manure storage in eastern Ontario. Am. Soc. Agric. Eng. (ASAE) Winter Meeting, Paper No. 83-4570 (December).

Sibbald, I. R.; Morse, P. M. 1983. Recent developments in the bioassay for true metabolizable energy in poultry feeding stuffs. Proc. of the 2nd International Network of Feed Information Symposium, Sydney, Australia. pp. 239-242 (August).

Sidaway-Wolf, D. 1983. An overview of energy use in food and agriculture. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. 8340-I506. 33 pp. (June).

Thompson, B. K. 1983. The use of statistics in assessing the results from experiments with vegetable oils fed to test animals. *In* High and low erucic acid rapeseed oils. Academic Press. pp. 515-534 (April).

Thuns, A.; Morrison, B. A. 1983. Contract reports to May 1983/Rapports de contrat jusqu'à mai 1983. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. I503. 149 pp. (July).

Turnbull, J. E. 1983. Swine manure handling: New technologies. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. I474. 24 pp. (April).

Turnbull, J. E.; Fréchette, M. C. H.; Drolet, J. O. C. 1983. Performance of single-slope doubled trusses with nailed triple gusset plates. Can. Soc. Agric. Eng. (CSAE) Annual Meeting, Paper No. 83-420 (July).

Turnbull, J. E., ed.; Massé, D. I. 1983. Canada Plan Service glossary of farm building terminology/Canada Service de Plans glossaire des termes de bâtiment agricoles. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. 6722-I470. 50 pp. (January).

Turnbull, J. E.; Massé, D. I.; Lefkovitch, L. P.; Lowe, D. L. 1983. Performance and load-sharing with single-member versus double-member gable roof trusses. Can. Soc. Agric. Eng. (CSAE) Annual Meeting, Paper No. 83-421 (July).

Van Die, P.; LeBlanc, D. 1983. Sommaire des réalisations du programme de recherche et développement énergétiques dans l'agro-alimentaire (RDEAA)/Summary of achievements of Agriculture Canada's energy, research and development in agriculture and food (ERDAF) program. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. 8124-I530. 32 pp. (August).

Vigneault, C. 1983. Ice storage of winter coldness for agricultural applications. Am. Soc. Agric. Eng. (ASAE) Winter Meeting, Paper No. 83-6547 (December).

Vigneault, C. 1983. L'utilisation de la glace naturelle en agriculture. Agriculture 40:24-27 (September).

Voisey, P. W.; Poushinsky, G. P. 1983. 1983 Information systems forecast and plans 1983-1987. Eng. Stat. Res. Inst., Agriculture Canada, Rep. No. I549. 67 pp. (October).

Food Research Institute
Ottawa, Ontario

PROFESSIONAL STAFF

N. W. Tape, B.S.A., Ph.D.	Director
B. R. Maguire	Administrative Officer
K. Lapsley, B.Sc., M.Sc.	Food Science Services
L. Robichon-Hunt, B.Sc., M.Sc.	Nutrition Services

Processing Technology and Food Quality

D. Paton, B.Sc., Ph.D.	Program Leader; Processing technology extrusion cooking
W. F. Collins, B.Sc., Ph.D.	Phenolics chemistry
J. D. Jones, B.Sc., M.Sc., Ph.D., C.Chem., F.R.S.C., F.I.F.S.T.	Oilseed fractionation
C. Y. Ma, B.Sc., M.Sc., Ph.D.	Protein functionality
D. Oomah, M.Sc., Ph.D.	Cereal processing
J. N. Weisz, B.Sc.	Carbohydrate analysis
D. F. Wood, B.Sc., M.Sc., Ph.D.	Meat processing
P. J. Wood, B.Sc., Ph.D.	Carbohydrates

Dairy Products

D. B. Emmons, B.S.A., M.S., Ph.D.	Program Leader; Dairy products
V. Harwalkar, B.Sc., M.Sc., Ph.D.	Protein chemistry
R. C. McKellar, B.Sc., M.Sc., Ph.D.	Dairy product microbiology
H. W. Modler, B.S.A., M.S., Ph.D.	Dairy products
G. Paquett,[1] B.Sc.	Dairy products
R. P. Sinha, B.Sc., M.Sc., Ph.D.	Dairy product microbiology

Structure and Sensory Evaluation

I. R. Siddiqui, B.Sc., M.Sc., Ph.D., D.Sc., C.Chem., F.R.S.C., F.C.I.C.	Program Leader; Food quality—carbohydrates
D. Froehlich,[2] B.Sc., M.Sc.	Sensory evaluation
M. Kalab, M.Sc., Ph.D.	Electron microscopy

L. M. Poste, B.A.Sc., Dip. Tech.	Sensory evaluation
S. H. Yiu, B.Sc., M.Sc., Ph.D.	Microscopy

Safety and Nutrition

Z. Sabry, B.Sc., M.Sc., Ph.D.	Program Leader; Nutrition
R. A. Holley, B.Sc., Ph.D.	Meat microbiology
W. J. Mullin, L.R.I.C., Ph.D.	Analytical methodology
L. Nadeau, B.Sc., M.Sc.	Nutrient analysis
A. M. Paquet, B.Sc., Ph.D.	Amino acid and peptide chemistry
B. Picard, B.Sc., M.Sc., Ph.D.	Microbial biochemistry
L. F. Russell, B.Sc., M.Sc.	Nutrient analysis
M. R. Sahasrabudhe,[3] B.Sc., M.Sc., Ph.D.	Lipids
C. Willemot, B.Sc., M.Sc., Ph.D.	Lipid biochemistry

Departure

J. Holme, B.A., M.A., Ph.D. Resigned 11 February 1983	Director

VISITING SCIENTIST

B. W. Smallbone, B.Sc., Ph.D. National Research Council of Canada visiting fellow 1981–1983	Lipid chemistry

---

[1] Educational leave, University of California, Davis, 1982–1985.
[2] Educational leave, University of British Columbia, 1983–1984.
[3] Seconded to Headquarters, Planning and Coordination.

INTRODUCTION

The aim of the Food Research Institute is to assist Canada's food and beverage industry become more efficient, productive, and competitive by developing new and improved processing technology and ingredients and by improving food quality, safety, and nutritional value. This role is pursued via an active in-house research program focusing on dairy products, cereals, oilseeds, meats, food safety, and nutrition; by providing technical information and advice to industry; and by managing research contracts and grants to industry and universities, valued at $5.8 million in 1983.

The Institute structure was modified to establish a dairy team and a structure and sensory team, while maintaining a processing team and a safety and nutrition team.

Food safety and nutrition activities were strengthened by the addition of Dr. Z. Sabry and Mrs. Lina Robichon-Hunt. In addition to ongoing safety and nutrition research, the Institute participated in the development of the Agriculture Canada nutrient assessment program (AGNAP) and provided the Department with policy advice on nutrition issues.

Several new responsibilities were assigned to the Institute in 1983, including the management of the processing, distribution, and retail (PDR) research contract fund, coordination of Departmental food and nutrition activities, and chairing the Interdepartmental Committee on *Codex Alimentarius*. Ms. Karen Lapsley joined the Institute to assist the new Director, Dr. Norman W. Tape, with these additional responsibilities.

Two patents were granted to Institute staff in 1983: processing aqueous-treated cereals by V. Burrows, G. Fulcher, and D. Paton; and polyurethane foam from oilseed byproducts by H. W. Modler, J. D. Jones, and A. Payne. Patent applications were also submitted concerning a continuous process for producing ricotta cheese (H. W. Modler) and novel derivatives of amino acids exhibiting antibotulinal properties (A. Paquet and K. Rayman).

This report covers only highlights of the total program. Enquiries should be directed to the Food Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

N. W. Tape
Director

FOOD PROCESSING

Extrusion cooking

Residence time distributions (RTD) for wheat starch in a single-screw extruder were measured and the data were fitted to a model that describes the flow pattern inside the extruder. Screw speed and moisture content exhibited the strongest effects on the RTD. Structural modifications to extruded starch were investigated by a combination of gel permeation chromatography (GPC), β-amylase, and pullulanase digestion and by intrinsic viscosity measurements. The GPC and intrinsic viscosity results showed that the average molecular size was significantly decreased as a function of extrusion conditions. The amylopectin component of starch was preferentially attacked through the mechanical rupture of only a very few covalent bonds. The GPC data were also correlated with the nominal shear stress and RTD inside the extrusion barrel. A first-order model was developed, which allows small-scale single-screw extruders to be used in predicting what might occur with larger-production single-screw equipment in an industrial setting.

Cereal chemistry and technology

Oat processing. A process for the aqueous treatment of oats has been developed and approved by the U.S. Patent Office. The patent is shortly expected to be officially issued. The process produces, as its principal product, a high yield of a refined oat flour. An oat bran–germ fraction is a secondary product. The availability of a high yield of oat flour, analagous to wheat flour, has previously not been possible through conventional roller milling. The process may be manipulated further to produce oat starch and an oat protein concentrate. Anyone interested in licensing this technology to determine economic feasibility should contact Canadian Patents and Developments Ltd. or the inventors at the Research Branch, Agriculture Canada, Ottawa.

Oat proteins. The thermal properties of oat globulins were studied by differential scanning calorimetry. Data show that oat globulins have exceptionally high thermal stability and resistance against denaturants, suggesting that oat proteins can retain functionality (favored by native protein structure) even when subjected to harsh processing conditions.

Oat globulins were fractionated by hydrophobic-interaction chromatography into five or six peaks. The fractions showed a progressive increase in surface hydrophobicity and hydrophobic amino acid content. Oat globulin antibodies were raised and used for immunofluorescent study of oat seeds. Results show an exclusive localization of globulins in the protein bodies of the embryo, and they were rapidly depleted during seed germination.

Oat phenolics. Phytochemical investigation of cereal grain phenolics have revealed a wide range of both free and covalently bound phenolic compounds. Studies have focused primarily on oat phenolics. The purpose of research is two-fold: to elucidate the structures of major low-molecular-weight constituents and to determine the potential physiological, sensory, and nutritional or antinutritional functionality of these compounds.

Using gel-permeation, ion-exchange, and hydrophobic-interaction chromatography, crude extracts from oat grain milling fractions have been fractionated into several classes. In addition to flavonoids and free phenolic acids, a number of aminophenolics have been isolated and identified from bran extracts. One such group consists of a series of β-linked glycosides of 2-amino-phenoxy-1-*O*-β-D-glycopyranoside, containing up to six or seven glycosyl residues. The aglycone 2-aminophenol is unstable in air and spontaneously oxidizes to the dimeric form, 2-aminophenoxazin-3-one. This dimeric derivative (Questiomycin B) has previously been isolated from several bacterial species. It is a potent gram-positive antibiotic and its mode of action closely resembles that of the Actinomycin antibiotic group. The same aminophenoxyglycosides have also been isolated from wheat and barley and are also likely present in corn.

Another group of aminophenolics that has been found only in oats consists of hydroxycinnamic acid amides of anthranilic acid (2-aminobenzoic acids). These derivatives probably occur in the grain as the corresponding cyclized derivatives (i.e. benzoxazin-4-ones). The major component has been identified as 6-hydroxy-2-(4′-hydroxystyryl)-4*H*-3,1-benzoxazin-4-one and its structure confirmed by total synthesis. This group of aminophenolics is partially responsible for the yellowish color of the outer part of the oat grain and may exhibit fungistatic properties. Further work on the structural chemistry of these aminophenolics is in progress.

Protein functionality. Specific chemical modifications (deamidation, succinylation, carboxyl modification) were employed to study the relationship between the physicochemical properties of wheat gluten and egg-white proteins and their functional performance in baked products. The results suggest that hydrogen and hydrophobic bondings are important in breadmaking, whereas electrostatic interaction is influencing the cake-baking performance of egg-white proteins. Various chemical modifications (acylation, treatments with proteinase, polyphosphate, and fatty acid salt) were also used to improve the functional properties of proteins from oats and cheese whey. This may enhance the utilization of these proteins in food formulations (e.g., meat emulsion, cake mix), which at present require more expensive protein ingredients.

Composite flours. Composite blends of wheat and oat flours were evaluated in terms of their bread- and cookie-making quality. A roller-milled and comminuted whole oat flour was investigated in composites containing up to 25% oat flour. Dough development time, dough strength, centrifuge water retention, and loaf volume decreased and mixing tolerance increased as the amount of oat flour in the composite increased. Slight differences existed between the two oat flours in the magnitude of effects, pasting behaviors, and loaf-volume response to oxidants and sodium stearoyl-2-lactylate. There was no significant difference in the rate of gas production of wheat flour and composite doughs. Cookie spread factors increased with increasing amounts of roller-milled oat flour in the formulation, whereas those of the comminuted whole oat flour composites remained constant.

A series of composite central-response surface designs was used to study the relative contribution of oxidants (ascorbic acid or potassium bromate), water, and level of comminuted whole oat flour in a composite flour and to find the combination maximizing loaf volume. A nonparametric regression method was used to treat the experimental data. Oat flour was the only variable that significantly reduced loaf volume whereas water level increased it. At 61.6% water level, there was a high tolerance of loaf volume to potassium bromate. At 64% water level, oxidation requirements for optimization of loaf volume depended heavily on the level of oat flour in the composite. At high water levels (68–72%), optimum loaf volume needed only potassium bromate without ascorbic acid. Oat flour had no effect on the oxidative requirement of composite flours at high water levels. Differences in yeast batches dominated the oxidative requirements of composite flours.

These observations indicate that loaf volume of composites can be optimized by maximizing water level in the dough and controlling the oxidative action of yeast fermentation.

Gums. Development of new methodology for analysis of cereal β-glucan has continued. Addition of a fluorescent dye, Calcofluor, to solutions of partially purified oat (1→3),(1→4)-β-D-glucan gave precipitates which, on acid hydrolysis and high-performance liquid chromatography (HPLC), showed glucose as the only monosaccharide present. Similarly, crude extracts of oat flour (sodium carbonate buffer, pH 10) gave precipitates that showed essentially only glucose present. Congo Red was shown to be as effective a precipitating agent as Calcofluor. β-Glucan values determined by dye precipitation agreed with values obtained from subtracting starch (enzymically determined) from total glucan. Microscopic examination of extracted flour residue, even after three or four extractions, revealed residual β-glucan. Yield was improved by increasing the temperature of extraction from 45°C to 80°C. The dye precipitation technique remained effective even in the presence of increased quantities of starch. Neither sulfuric acid hydrolysis nor trifluoroacetic acid (TFA) hydrolysis give quantitative yields of glucose from β-glucan or starch. With 0.5 *M* TFA at 120°C a maximum yield of 90–93% anhydroglucose was obtained after 45–60 min. Extrapolation of the subsequent approximately linear portion of the yield curve to zero time showed anhydroglucose values in the range 98–102% for both purified β-glucan and starch.

Under contract at the POS Pilot Plant, Saskatoon, approximately 18 kg of oat gum have been prepared for further evaluation in nutritional and functionality studies.

Oilseeds

Oils prepared from the low erucic acid rapeseed (LEAR) cultivar Tower by two separate methods were compared in feeding experiments on male rats. The first oil was commercially extracted and refined; the second was direct solvent extracted under mild heat and low seed moisture conditions and was used unrefined. The direct-solvent-extracted oil contained less sulfur and more color. Both oils showed similar fatty acid composition.

Male rats grew better on the direct-solvent-extracted oil. Their cardiopathogenic response was similar for both oils. These observations precluded the possibility that contaminants in the oil caused heart lesions and supported the fact that these lesions were related to the fatty acid composition of the dietary fat.

A contracted study at the University of Toronto attempted to reduce the pollution caused by a whey by-product during the preparation of a rapeseed protein isolate by hexametaphosphate-complexing. Optimum recovery of solids precipitate was observed by treating the effluent with 1% bentonite at pH 4.5. Treatment of the effluent with sodium lignosulfonate was slightly less effective. Precipitates recovered from both treatment procedures contained good essential amino acid patterns and no detectable glucosinolate content.

Studies undertaken under contract at the University of Laval have resulted in the development of a dialyzing cell to separate the digested protein and measure quantitatively the amino acids released as a function of time. The digestion was achieved with pepsin and pancreatin in vitro. Casein, soy protein, and rapeseed protein were extensively digested in a relatively short time. Differential release rates of amino acids were readily observed, as well as retarded amino acid release after heat and alkali treatment of the proteins. The dialysate comprised a mixture of amino acids and small peptides released in a process reflecting enzyme specificity. Prolonged digestion up to 24 h decreased the pronounced differences in amino acid release and resulted in extensive liberation of the slowly released amino acids.

This in vitro digestion–dialysis technique presents interesting possibilities as a method of determining the amino acid availability after digestion of proteins in foods after various treatments involving physical and chemical processes.

In the processing of rapeseed to prepare a protein concentrate, appreciable quantities of by-products are formed. Methods have been sought to use the by-products so as to recover some of the cost of the processing and to overcome the problem of by-product disposal. In the FRI-75 process, two important by-products are available, the seed coat fraction and the extractives comprising almost entirely water-soluble components such as sugars, glucosinolates, and phenolic derivatives. Both these fractions have been found to be suitable polyol substrates for manufacturing polyurethanes. A patent has been granted for this invention.

Meat processing

Studies have continued in-house and by contract on new analytical techniques that may improve the current least-cost formulation data used for the manufacture of comminuted meat products. In preliminary studies the ability of various meats to retain added moisture or brine after cooking (RM_w, RM_b) has been shown to correlate highly with exudate release in vacuum-packaged weiners. These studies are now being expanded to include a greater variety of meat cuts. In addition a method for measuring surface hydrophobicity (S_0) of intact salt-soluble muscle proteins has been developed under a contract at the University of British Columbia. The methodology is currently being used to collect S_0 data and correlate these data with emulsion stability and capacity data.

In-house studies have shown that there is a considerable loss in extractability of salt-soluble proteins between prerigor and postrigor beef muscle. Extractability is least at 3 days postslaughter and by 10 days there appears to be an increase in extractability. RM_w, RM_b, and S_0 data have also been collected in order to correlate these parameters with other meat functional properties.

Through further contract research the use of mechanically separated meats (poultry and pork) in fresh-sausage emulsion has been studied from a chemical, microbiological, nutritional, and sensory point of view. Contract research is continuing in a search for an alternate to nitrite in meat-curing systems.

DAIRY PRODUCTS

Psychrotroph proteinases

Test for proteolysis. There is a need for rapid, simple tests to detect psychrotroph proteinases in milk. A test based on the digestion of an insoluble protein–dye complex, hide powder azure (HPA), has been developed and compared with the trinitrobenzene sulfonic acid (TNBS) method for detecting free amino groups in milk resulting from proteolytic degradation of milk proteins. The two methods were equally sensitive when used to measure the activity of three psychrotroph proteinases in pasteurized milk; however, the HPA method was simpler to perform. Studies to assess the commercial value of the HPA test have been proposed.

Phosphate and proteinase production. With a view to controlling the growth and proteinase-producing ability of psychrotrophs in milk, the effect of nutrient limitation on proteinase synthesis in defined medium was examined. Proteinase production was maximal when carbon, nitrogen, and phosphate were in excess. This is in contrast to other microorganisms that normally produce proteinases in response to nutrient limitation. Excess metabolizable phosphate as well as polyphosphates and chelating agents repressed proteinase production, suggesting a role for divalent cations in proteinase synthesis by psychrotrophic bacteria.

Genetics of lactic acid bacteria

The effect of storage on the stability of lactose-metabolizing gene(s) at low pH was investigated, using six cheese-starter cultures of commercial importance. Some strains lost the lactose-metabolizing characteristic very quickly when stored at room temperature (18–20°C). Addition of phosphate to the medium helped in stabilizing this characteristic.

Phosphate also affected the growth of cultures, their morphology, and their antibiotic-resistance levels. In the presence of phosphate, the resistance levels of all the cheese-starter cultures and thermophilic streptococci to aminoglycoside antibiotics were increased while resistance levels to penicillin, tetracycline, and erythromycin were drastically decreased. This new information provided evidence for developing a unified method for testing the antibiotic resistance of lactic acid bacterial cultures.

Whey protein denaturation and aggregation

The thermal denaturation and aggregation behavior of β-lactoglobulin was altered by chemical modification of $-NH_2$ and $-COOH$ groups. Increasing extent of modification from 10% to 90% reduced their thermal gelation and aggregation ability. The reduced ability to gel or aggregate was partially overcome by increasing ionic strength (up to 0.5) and protein concentration (up to 10%) and by lowering pH below the isoelectric point.

Stability of vitamin A in skim milk powder during storage

Vitamin A in hydrogenated coconut oil (HCO) at 50°C was metered into concentrated skim milk just ahead of the high-pressure pump to the spray dryer. Preliminary results show that higher levels and type of antioxidants in the oil carrying the vitamin A affected the stability during storage. In both pilot-plant and commercial-plant drying trials the best antioxidant was a commercial preparation containing BHA, BHT, and α-tocopherol; 2000 ppm of a commercial antioxidant containing α-tocopherol and ascorbyl palmitate was better than 500 ppm. Higher levels of HCO in the powder (0.05–0.20%) also appeared to give better stability.

In instant powder, vitamin A was added by spraying a skim-milk-based emulsion containing the vitamin into the instantizing chamber. Preliminary results show that in this application, higher amounts of HCO also slightly improved stability. The blend of antioxidants of BHA, BHT, and α-tocopherol was better than that containing α-tocopherol and ascorbyl palmitate. Vitamin A in beadlet form was equally stable at 22°C storage, whether dry-blended before instantizing chamber or dispersed in cold water for spraying into the instantizing chamber. The dry-blended beadlet was the most stable form when the vitamin-fortified powder was stored at 37°C.

Continuous cheese production

A process was developed whereby ricotta and Quesco Blanco cheese can be produced on a continuous basis. Milk or blends of milk and whey were continuously heat-treated, acidified, and fractionated into curd and deproteinated whey. In the case of ricotta, blends of 80–90% whey and 20–10% whole milk or skim milk were used while Quesco Blanco was manufactured from either whole milk or milk standardized to 3% fat. Excellent-quality cheese was obtained and it has good potential as a base for other dairy foods, e.g., processed cheese, cheese food, or spreads and cream cheese.

Cottage cheese from highly heated milk

Heating skim milk at 110°C yielded slightly better curd than heating at 95 or 80°C. Heating to give 85% of denatured whey proteins yielded slightly better curd than heating to give 95% denaturation. While curd quality was satisfactory in breakage during cooking and in firmness, a problem of mealiness remains.

Syneresis of yogurt

Improvement in the firmness and resistance to syneresis of yogurt was observed when heated milk or concentrate was cold stored (~6°C) for 1–3 days. This effect could be of practical significance and is under further investigation. Lower temperature of inoculation (30°C), suspected to result in weaker gels, was shown to be less critical to the syneresis problem. Syneresis in yogurt was correlated to microstructure.

Whey as animal feed and fertilizer

With rising fertilizer and feed costs in Canada, there has been renewed interest in utilizing this cheese by-product to increase profitability of swine, beef, and dairy operations. In swine and beef operations, whey can be used to replace 25–35% of the normal ration and this translates into a net savings of approximately $10 and $50, respectively, per animal finished at normal slaughter weights. With lactating cows the savings are approximately 15% but it can reach 40–45% for heifers and nonlactating cows. One cheese factory in Ontario has established their own farm and currently feeds most of its whey production to 800 beef cattle. Weight gains have been excellent and over 85% of the dressed animals have graded A1 and A2.

Whey is also an excellent fertilizer. An application rate of 2.5 cm/ha (2470 hL) supplies 309 kg N, 197 kg P_2O_5 and 321 kg K_2O and represents a saving of over $274/ha. Whey is particularly well-suited for corn as high levels of nitrogen are released slowly to the corn plant during the course of the growing season.

STRUCTURE AND SENSORY EVALUATION

Carbohydrates

The work on the collaborative tobacco project has been extended to the identification and characterization of the sodium hydroxide soluble, cell-wall polysaccharides of cured tobacco leaf laminae (*Nicotiana tabacum* L. 'Delhi 76'). Fractionation of the sodium hydroxide soluble polysaccharides yielded a major hemicellulose-B fraction. Further fractionation of B by chromatography on diethylaminoethylcellose (CO_3^{2-}) and borate yielded an amyloid (arabinoxyloglucan) that was homogeneous on the ultracentrifuge; had $[\alpha]_D^{22}$ +29°; and on hydrolysis produced L-arabinose, D-xylose, and D-galactose in the molar ratios of 1:2.2:6.8. Methylation of the amyloid and analysis of methylated fragmentation products using a combination of paper chromatography, demethylation, reduction, and acetylation has revealed its main structural features. The methylation analysis data show a repeating unit of 20 sugar residues consisting of five terminal, nonreducing end groups (three D-xylose and two L-arabinose). There are five residues of D-glucose involved in branching, through positions four and six. The remaining 10 nonterminal residues consist of two (1→2)-linked D-xylose units and eight (1→4)-linked D-glucose units.

The presence of about 0.1 mol of 2,3,4,6-tetra-*O*-methyl and 2,3,4-tri-*O*-methyl-D-glucose each suggested that an average unit may contain 102 sugar residues.

Fluorescence microscopy

A new microscopic technique has been developed and applied to the investigation of oriental mustard seeds infected with yeast (*Nematospora coryli*). This technique makes use of sensitive fluorescent markers (aniline blue and congo red) that can bind to the yeast structures and make them distinguishable from the seed structures when examined under a fluorescence microscope. The pathway of infection was traced by localizing the microorganisms in different tissues of the seed with the above markers. Yeast spores were seen spreading from the exterior of the seed, through the seed coat (hull), into the periphery of the embryo. Yeast structures (asci and spores) were found within the damaged tissues of the cotyledon. The above findings indicate that additional processing steps other than cleaning would be required to treat the infected seeds if they were to be used.

Various fluorescent markers and microscopic techniques have been used to study the effects of commercial processing on the microchemical organization of rapeseed. Results of the studies showed that mechanical crushing tended to disrupt cell walls. After cooking and expeller pressing, individual protein bodies fused to form large masses encompassing phytin-containing globoids. Storage lipids also coalesced into larger droplets. Most of the oil was removed after solvent extraction and was absent inside cotyledon cells after desolventization. The final meal product contained primarily hull and cotyledon fragments. The cotyledon fragments consisted of an amorphous protein matrix embedded with phytin globoids and supported by a network of broken cell walls. The structural and microchemical organization of the hull was not much affected by the processing. Phenolic compounds, mucilage, cell wall polysaccharides, chlorophyll, storage proteins, and lipids could be detected by various fluorescence microscopic techniques.

Microstructure

Development of artefacts related to sample preparation and operation of the microscope was recorded at all stages of scanning electron microscopy of milk products, and corrective measures have been suggested to produce micrographs free from artefacts.

A method based on the use of imidazole-buffered osmium tetroxide was developed for the fixation and staining of fungi in soft (mold-ripened) cheeses. Micrographs of both the fungi and the cheese protein are superior to those obtained by other techniques and make it possible to study the growth of microorganisms in such cheeses.

Additional electron microscopical studies were carried out on yogurt fortified with milk solids isolated by electrodialysis, reverse osmosis, and ultrafiltration. Graphical models of yogurt microstructure have been devised and subjected to a simple digital image analytical technique with the objective of comparing the various microstructures according to quantitative (numerical) parameters such as the density of the protein matrix (number of casein micelles in unit volume) and the dimensions of void spaces.

Collaborative studies resulted in the finding that mucilage in yellow mustard seeds is located under the seed coat in freshly harvested seeds but oozes out through the seed coat in seeds that had been exposed to moisture.

Other collaborative studies indicated that light micrographs of wieners histologically stained for fat, protein, and starch were easier to interpret than micrographs obtained by scanning electron microscopy (SEM); this finding is related to the heterogeneity and relatively coarse microstructure of the wieners. Unlike SEM, light microscopy is suitable for providing data for digital image analysis of these food products.

Collaboration with North American and European food science laboratories has been continued.

Sensory evaluation

Work on projects concerning flavor, texture, and aroma of beef, effect of frequency of collection on the flavor of eggs, and the warmed-over aroma of cooked pork was undertaken. Besides the service work, the unit offered a 5-day short course, participated in seminars, and continued to communicate with industry, government departments, and universities. Additionally, work has commenced on three methods of data analysis of magnitude estimates, and a computer system for multidimensional scaling has been installed.

Turkey rolls were evaluated to determine the effect on eating quality of sex and fat content. Differences due to sex were found, with the females being more tender, juicy, salty, and having more off-flavor than the males, which had more turkey flavor. Other work on turkeys involved the effect of strain (Nicholas and British United Turkey (BUT)) and feed (the European Economic Community (EEC) and North American feeding systems) on eating quality. Sensory evaluation of the cooked breast indicated that there was a strain effect. The meat from the Nicholas toms was more tender, juicy, and acceptable compared to BUT toms; no differences in turkey flavor and off-flavors were detected. The meat from the thighs showed no difference due to strain. There was, however, an indication of off-flavor in meat from both strains that were fed according to the EEC system, presumably arising from the use of fish meal in the feed.

Removal of lysozyme from egg albumen was studied. Angel cakes prepared for each of three treatments (freeze-dried albumen with and without lysozyme and a control that consisted of spray-dried albumen) were compared for differences in cake volume, specific gravity of meringue, whipping time, specific gravity of batter, texture, and shrinkage. No significant differences were found between cakes made with the freeze-dried albumens; however, there were differences between the freeze-dried and spray-dried albumens. More work will be carried out in this area.

The effect of an aspen wood chip diet on the eating quality of Charolais beef was evaluated. Scores for flavor, tenderness, and juiciness showed significant difference in flavor, with the beef fed a control diet having a more intense beef flavor than the beef fed an aspen wood chip diet. The Warner–Bratzler mechanical shear values indicated the control diet beef to be significantly more tender than the aspen wood chip diet beef.

The aroma and appearance of uncooked beef inoculated with *Clostridium botulinum* and stored for varying lengths of time were evaluated for acceptability in a two-phase study extending over 9 days and 5 days. The purpose of the study was to determine the point, in days, that a laboratory panel could tell that the inoculated meat was "suspect" by means of aroma and appearance.

The current work involves the sensory properties of pasta and warmed-over aroma in pork and collaborative work with the Dairy, Fruits and Vegetable Division to develop a certification program for butter graders.

FOOD SAFETY AND NUTRITION

Starter cultures in meat fermentations

A series of uncooked salami formulations containing 0, 5, 10, and 15% raw, mechanically deboned poultry meat were inoculated with *S. aureus*, *Salmonella typhimerium*, or *C. sporogenes* and dry cured under commercial conditions, without cooking. Whereas no inoculated organism grew under these conditions, the natural fermentation was not sufficiently rapid to eliminate them during the initial fermentation period. A study of factors affecting survival and rapid growth of six commercial lyophilized starter cultures was undertaken. Optimum survival was obtained after a resuscitation period of up to 1 h at 4°C in a complete nutrient medium.

Shelf life of cured meats

In a contract study, spoilage patterns of meat loaves, pastrami, and ham were followed. Microbiological and organoleptic changes were noted after packaging under vacuum or nitrogen and with storage at –4, 0, 3, or 7°C. In all cases lactobacilli dominated microbial populations within 4 wk. The development of meat spoilage patterns under vacuum or nitrogen was not significantly different. Temperature was the most important factor studied that influenced shelf life of meat. Nitrogen packaging may be of value for cured meats known to be prone to fungal spoilage. However, the advantages thereby realized are not great enough to warrant its use to replace vacuum packaging in low-oxygen-permeable films.

Contamination of mustard flour by *Nematospora* yeast

When oriental mustard seed infected with *Nematospora* yeast was germinated, the parasite was killed. Nonetheless, yeast contamination of mustard flour prepared from infected seed was an unresolved problem as it showed viable organisms when subjected to microbiological examination using conventional methods. Endogenous seed myrosinase was found to be a key factor in generating this toxicity through its action upon allyl glucosinolate to produce allyl isothiocyanate. Isolation of myrosinase from its substrate in the seed by plant cell compartmentation was also considered an important factor in reducing in vitro toxicity. Fluorescence and scanning electron microscope studies of the yeast infection revealed that physical injury to the seed, probably as a result of insect parasitization, was a prerequisite for successful invasion of the seed. Whereas yellow mustard was also highly toxic to the yeast through myrosinase production of *p*-OH benzyl isothiocyanate, rapeseed possessed no detectable in vitro toxicity toward the yeast. Naturally infected oriental (*Brassica juncea*) and yellow mustard (*B. hirta*) seeds, but not rapeseed (*B. napus, B. campestris*), have been noted in Canadian crops.

Nitrite and nitroso compounds

Nitrite. A study of the antioxidant mechanism of nitrite, which retards the development of warmed-over flavor (WOF) in cooked cured meat, has been initiated in order to facilitate the replacement of nitrite, a potential source of carcinogenic nitrosamines, by other treatments. The oxidation of polyunsaturated fatty acids (PUFA) is known to be responsible for the development of WOF. Lipid methodology was adapted to permit detailed analysis of large numbers of small samples. Detailed analysis of lipids of ground lean pork meat was carried out after cooking, during the development of warmed-over flavor upon storage at 4°C for 8 days. Extensive degradation of PUFA occurred in the polar lipid fraction but not in the triglycerides. The effect of nitrite on PUFA occurred in the polar lipid fraction but not in the triglycerides. The effect of nitrite on PUFA breakdown will be investigated.

Antimicrobial action of nitrite. C. sporogenes was used as a model microorganism to gain further insights into nitrite's antimicrobial mode of action. Methodology to allow the identification of ability to produce adenosine triphosphate was developed. Specific substrate-linked phosphorylation pathways were scanned for and found effective in *C. sporogenes*. General targets of nitrite's action in the energy metabolism were identified.

Nitrite replacers. A series of novel amino acid derivatives were synthesized and tested for inhibition of *Clostridium botulinum* in meat slurries (collaborative project with Health and Welfare Canada). Five compounds exhibited a strong effect. Patent application has been submitted to Canadian Patent and Development Ltd. and is being evaluated.

Nitroso compounds. Supernatant fractions from different organs of beef and rat origin were tested for their effect on the mutagenic activity of several carcinogens belonging to *N*-nitroso groups. Among all the organs tested, both beef and rat liver supernatant fluids completely inhibited the mutagenic actions on *N*-methyl *N*'-nitro-*N*-nitrosoguanidine, methyl methanesulfonate, ethyl methanesulfonate, and nitrosopyrrolidine. The liver fraction also contained an antibacterial agent that was separated from the antimutagenic property by dialysis.

Lipids

Vegetable oils. Soybean, canola, and sunflower oils, from various stages of processing, were analyzed to determine their *cis*- and *trans*-octadecanoate positional isomer distribution. The variety of positional isomers formed during partial hydrogenation depended upon their fatty acid composition and the degree of hydrogenation required.

In collaboration with industry, under a contract research project, 20 samples of canola oil hydrogenated under laboratory conditions employing seven different commercial catalysts were examined. Significant differences were found in the *trans* fatty acid contents, particularly the *trans*-diene (0.1–5.5%).

Poultry. Total lipid was extracted from the meat and skin portions of the breast, thigh, and drumstick of broilers and roasters. No significant differences were found in the fatty acid composition between broilers and roasters. The skin contained 41–69% total lipid, of which 98% was neutral and accounted for 8–18% of the total weight of the three chicken parts analyzed.

Oats. Time and temperature relationships for the inactivation of lipase in oats (Hinoat and Sentinel) were established. At 20% moisture, lipase was inactivated in 30 min at 100°C. These conditions are commercially applicable.

Bioavailability of L- and D-methionine in proteins

Seven dietary protein fragments (tripeptides) similar to those present in legume seed and milk protein were synthesized: Ala–Met–Ala, Val–Met–Phe (milk protein), Thr–Met–Arg, and Thr–Met–Lys (soy protein), as well as their epimers with D-methionine replacing L-methionine. Nutritive evaluation of these compounds in rat-feeding experiments (collaboration with Health and Welfare Canada) showed that the bioavailability of L-methionine decreases with the increasing bulkiness of adjacent amino acids: 72% of Met was utilized from Ala–L-Met–Ala (alanine being a small amino acid) and only 47% of Met was utilized from the bulky Thr–L-Met–Arg. D-Methionine on internal sites of peptides is little available to rats with zero availability in bulky peptides. These findings suggest that the racemized methionine, resulting from alkaline treatment of dietary proteins, loses its nutritional value.

Vitamins

Bioavailability. Official methodology, adopted by the Association of Official Analytical Chemists (AOAC), has been established for the analysis of thiamine, riboflavine, and niacin in pure solutions and in foodstuffs (cereal products). Development of a high-performance liquid chromatography (HPLC) procedure to analyze for these vitamins is also in progress.

Model (in vitro) systems of the stomach and the intestine have been developed where temperature, pH, and enzyme conditions were replicated from in vivo systems. The effect of grinding of wheat bran (cultivar Frederick) on the in vitro bioavailability of thiamine, riboflavin, and niacin was investigated. Fine- and coarse-particle-sized bran were treated with stomach and intestinal enzymes in an in vitro model system. No significant differences were observed.

Vitamin C. A survey of the total and reduced vitamin C contents of imported and domestic fresh tomatoes was initiated. On the basis of 1983 data, the vitamin C contents of fresh tomatoes available on the retail market in Ottawa appeared similar to imported and domestic produce. L-Ascorbic acid in imported fresh tomatoes ranged from 16 to 23 mg/100 g fresh weight, and in domestic samples, from 13 to 23 mg/100 g. L-Ascorbic acid was the predominant form of the vitamin.

An HPLC method to determine L-ascorbic acid in fresh produce is being developed to increase the selectivity and efficiency of vitamin C analysis.

Folacin. Further work on the stability of folacin in ground bran samples has shown that there is no significant loss of total folacin during storage for up to 6 mo at 25°C. Chromatographic methods for fractionation of folacin are being investigated with the purpose of finding an alternative to the time-consuming microbiological assay.

PUBLICATIONS

Research

Davidson, V. J.; Paton, D.; Diosady, L. L.; Spratt, W. A. 1983. Residence time distributions for wheat starch in a single screw extruder. J. Food Sci. 48:1157-1161.

Dodds, K. L.; Holley, R. A.; Kempton, A. G. 1983. Evaluation of the catalase and *Limulus* amoebocyte lysate tests for rapid determination of the microbial quality of vacuum-packed cooked turkey. Can. Inst. Food Sci. Technol. J. 16:167-172.

Harwalkar, V. R.; Beckett, D. C.; McKellar, R. C.; Emmons, D. B. 1983. Age-thickening and gelation of sterilized evaporated milk. J. Dairy Sci. 66:735-742.

Harwalkar, V. R.; Kalab, M. 1983. Susceptibility of yoghurt to syneresis. Comparison of centrifugation and drainage methods. Milchwissenschaft 38:517-522.

Farnworth, E. R.; Kramer, J. K. G.; Jones, J. D.; Thompson, B. K.; Corner, A. H. 1983. The effect of commercial processing on the nutritional and cardiopathological quality of low erucic acid rapeseed oil. Can. Inst. Food Sci. Technol. J. 16:111-115.

Fenwick, G. R.; Heaney, R. K.; Mullin, W. J. 1983. Glucosinolates and their breakdown products in food and food plants. Crit. Rev. Food Sci. Nutr. 16:123-201.

Froehlich, D. A.; Gullet, E. A.; Usborne, W. R. 1983. Effect of nitrite and salt flavour and overall acceptability of ham. J. Food Sci. 48:152-154 and 171.

Holley, R. A.; Phipps-Todd, B. E.; Yiu, S. H. 1983. Infection of oriental mustard by *Nematospora*: A fluorescence and scanning electron microscope study. Food Microstruct. 2:143-151.

Holley, R. A.; Timbers, G. E. 1983. *Nematospora* destruction in mustard seed by microwave and moisture treatments. Can. Inst. Food Sci. Technol. J. 16:68-75.

Jenkins, K. J.; Emmons, D. B. 1983. Inhibitory effects of fatty acids, chelating agents, and other substances on rennet clotting of skim milk. J. Dairy Sci. 66:719-726.

Kalab, M. 1983. Electron microscopy of foods. *In* Bagley, E. B.; Peleg, M., eds. Physical properties of foods. AVI Publishing Co., Inc., Westport, Connecticut. pp. 43-104.

Kalab, M.; Allan-Wojtas, P.; Phipps-Todd, B. E. 1983. Development of microstructure in set-style nonfat yoghurt—A review. Food Microstruct. 2:51-66.

Lee, B. H.; Simard, R. E.; Laleye, L. C.; Holley, R. A. 1983. Microflora, sensory and exudate changes of vacuum- or nitrogen-packed veal chucks under different storage conditions. J. Food Sci. 48:1537-1542 and 1563.

Ma, C.-Y. 1983. Chemical characterization and functionality assessment of protein concentrates from oats. Cereal Chem. 60:36-42.

Ma, C.-Y. 1983. Preparation, composition and functional properties of oat protein isolates. Can. Inst. Food Sci. Technol. J. 16:201-205.

Ma, C.-Y.; Amantea, G. F.; Nakai, S. 1983. Production of nonbitter, desalted milk hydrolysate for fortification of soft drinks and fruit juices. J. Food Sci. 48:897-899.

McGregor, D. I.; Mullin, W. J.; Fenwick, G. R. 1983. Analytical methodology for determining glucosinolate composition and content. J. Assoc. Off. Anal. Chem. 66:825-849.

Michaud, R.; Richard, C.; Willemot, C.; Gasser, H. 1983. Apica alfalfa. Can. J. Plant Sci. 63:547-549.

Modler, H. W.; Larmond, M. E.; Lin, C. S.; Froehlich, D.; Emmons, D. B. 1983. Physical and sensory properties of yogurt stabilized with milk proteins. J. Dairy Sci. 66:422-429.

Murray, S. K.; Kwan, K. K. H.; Skura, B. J.; McKellar, R. C. 1983. Effect of nitrogen flushing on the production of proteinase by psychrotrophic bacteria in raw milk. J. Food Sci. 48:1166-1169.

Nakai, S.; Amantea, G.; Eugster, K.; Jung, L.; Ma, C.-Y.; Nilsson, E. K.; Suyama, K.; Emmons, D. B. 1983. Vitamin A and haylike flavour in nonfat dry milk and pasteurized low fat milks. Can. Inst. Food Sci. Technol. J. 16:116-122.

Oehlrich, H. K.; McKellar, R. C. 1983. Evaluation of an 18°C/45-h plate count technique for the enumeration of psychrotrophic bacteria in raw and pasteurized milk. J. Food Prot. 46:528-529.

Oomah, B. D. 1983. Baking and related properties of wheat–oat composite flours. Cereal Chem. 60:220-225.

Oomah, B. D.; Bushnuk, W. 1983. Characterization of lupine proteins. J. Food Sci. 48:38-41.

Porteous, J. D.; Wood, D. F. 1983. Water-binding of red meats in sausage formulation. Can. Inst. Food Sci. Technol. J. 16:212-214.

Russell, L. F.; Mullin, W. J.; Wood, D. F. 1983. Vitamin C content of fresh spinach. Nutr. Rep. Int. 28:1149-1157.

Sahasrabudhe, M. R.; Smallbone, B. W. 1983. Comparative utilization of solvent extraction methods for determination of total, neutral and polar lipids. J. Am. Oil Chem. Soc. 60:801-805.

Siddiqui, I. R.; Rosa, N. 1983. Low molecular weight carbohydrates of tobacco. Tob. Sci. 27:130-134.

Simard, R. E.; Lee, B. H.; Laleye, C. L.; Holley, R. A. 1983. Effects of temperature, light and storage time on the microflora of vacuum- or nitrogen-packed frankfurters. J. Food Prot. 46:199-205.

Simard, R. E.; Lee, B. H.; Laleye, C. L.; Holley, R. A. 1983. Effects of temperature, light and storage time on the physicochemical and sensory characteristics of vacuum- or nitrogen-packed frankfurters. J. Food Prot. 46:188-195.

Sinha, R. P.; Parulekar, M. R. 1983. Effect of mammalian tissues on mutagenicity of several *N*-nitroso compounds. J. Food Prot. 46:109-114.

Soucy, K.; Randall, C. J.; Holley, R. A. 1983. Microbiological monitoring of hatchery sanitation. Poult. Sci. 62:298-309.

Thompson, L. U.; Jones, J. D. 1982. Treatment of rapeseed process effluents with bentonite and lignosulfonate. Can. Inst. Food Sci. Technol. J. 15:262-266.

Torrie, J. P.; Cholette, H.; Froehlich, D. A.; McKellar, R. C. 1983. Growth of an extracellular proteinase-deficient strain of *Pseudomonas fluorescens* on milk and milk proteins. J. Dairy Res. 50:365-374.

Trevors, K. E.; Holley, R. A.; Kempton, A. G. 1983. Isolation and characterization of a *Lactobacillus plantarum* bacteriophage isolated from a meat starter culture. J. Appl. Bacteriol. 54:281-288.

Urquhart, A. A.; Altosaar, I.; Matlashewski, G. J.; Sahasrabudhe, M. R. 1983. Localization of lipase activity in oat grains and milled oat fractions. Cereal Chem. 60:181-183.

Vachon, C.; Gauthier, S. F.; Jones, J. D.; Savoie, L. 1982. Enzymatic digestion method with dialysis to assess protein damage. Application to alkali-treated proteins containing lysinoalanine. Nutr. Res. 2:670-680.

Vachon, C.; Gauthier, S. F.; Jones, J. D.; Savoie, L. 1983. In vitro enzymatic release of amino acids from alkali-treated proteins containing lysinoalanine. Nutr. Rep. Int. 27:1303-1313.

Voutsinas, L. P.; Nakai, S.; Harwalkar, V. R. 1983. Relationship between protein hydrophobicity and thermal functional properties of food proteins. Can. Inst. Food Sci. Technol. J. 16:185-190.

Willemot, C. 1983. Rapid degradation of polar lipids in frost damaged winter wheat crown and root tissue. Phytochemistry 22:861-863.

Wood, D. F.; Froehlich, D. A. 1983. The effect of electrical stimulation on sensory and physical properties of steaks from three grades of Canadian beef after commercial handling. Can. Inst. Food Sci. Technol. J. 16:52-56.

Wood, P. J.; Fulcher, R. G. 1983. Dye interactions—A basis for specific detection and histochemistry of polysaccharides. J. Histochem. Cytochem. 31:823-826.

Wood, P. J.; Fulcher, R. G.; Stone, B. A. 1983. Studies on the specificity of interaction of cereal cell wall components with congo red and calcufluor. Specific detection and histochemistry of $(1\rightarrow3),(1\rightarrow4)$-$\beta$-D-glucan. J. Cereal Sci. 1:95-110.

Yiu, S. H.; Fulcher, R. G.; Altosaar, I. 1983. The effects of commercial processing on the structure and microchemical organization of rapeseed. Food Microstruct. 2:165-173.

Zee, S. Y.; Chan, H. Y.; Ma, C.-Y. 1983. Histochemical studies of scutellum during germination of oat seed by light microscopy and immunofluorescent localization of oat globulin. Acta Bot. Sin. 25:505-511.

Miscellaneous

Fulcher, R. G.; Wood, P. J. 1982. Identification of cereal carbohydrates by fluorescence microscopy. Pages 111-147 *in* Bechtel, D. B., ed. New frontiers in food microstructure. Am. Assoc. Cereal Chemists, St. Paul, Minnesota.

Jenkins, K. J.; Emmons, D. B. 1983. Tolerance of calves to oxidized fat in milk replacer. Canadex 401.68.

Jenkins, K. J.; Emmons, D. B. 1983. Supplementing calf milk replacers with amino acids. Canadex 401.68.

Jones, J. D. 1982. Processing canola or rapeseed meal. Pages 827-831 *in* Grains and oilseeds; handling, marketing, processing. Can. Intl. Grains Inst., Winnipeg, Man.

Modler, H. W. 1982. Canadian whey research program. Proc. Whey Products Conference, Schaumburg, Ill. 21-22 October. pp. 39-48.

Paton, D. 1983. Analytical problems in extrusion cooking. Proc. 7th World Cereal and Bread Congress, Prague, Czech. pp. 915-920.

Land Resource Research Institute
Ottawa, Ontario

PROFESSIONAL STAFF

J. S. Clark, B.S.A., M.Sc., Ph.D.	Director
J. C. van Schaik, M.Sc., Ph.D.	Deputy Director
M. B. Trudel	Administrative Officer

Soil Resource Inventory and Mapping

J. H. Day, B.S.A., M.S.A.	Head of Section; Correlation
J. A. Shields, B.S.A., M.Sc., Ph.D.	Soil correlation—Great Plains
C. Tarnocai, B.S.F., M.S.	Soil correlation—British Columbia and North

Atlantic Soil Survey (Truro)

F. Hender, B.Sc.	Party leader
P. K. Heringa, B.Sc., M.Sc.	Party leader
D. A. Holmstrom, B.S.A.	Party leader
H. W. Rees, B.Sc.	Party leader
K. T. Webb, B.Sc., M.Sc.	Party leader

Quebec Soil Survey (Sainte-Foy)

J. M. Cossette, B.Sc.	Head of Unit
L. Grenon, B.S.A.	Party leader
L. Lamontagne, B.Sc.	Party leader
M. C. Nolin, B.Sc., M.Sc.	Party leader

Ontario Soil Survey (Guelph)

C. J. Acton, B.S.A., M.Sc., Ph.D.	Head of Unit
R. K. Jones, B.Sc., M.Sc.	Party leader
E. W. Presant, B.S.A., M.Sc.	Party leader
G. J. Wall, B.S.A., Ph.D.	Party leader

Manitoba Soil Survey (Winnipeg)

R. E. Smith, B.S.A., M.Sc.	Head of Unit
R. Eilers, B.S.A., M.Sc.	Party leader
W. R. Fraser, B.Sc., M.Sc.	Party leader
W. Michalyna, B.S.A., M.Sc., Ph.D.	Party leader
H. Veldhuis, Ing., M.Sc.	Party leader

Saskatchewan Soil Survey (Saskatoon)

D. F. Acton, B.S.A., M.Sc., Ph.D.	Head of Unit
A. J. Anderson, B.Sc.	Party leader
W. D. Eilers, B.S.A., M.Sc.	Party leader
L. M. Kozak, B.S.A., M.Sc., Ph.D.	Party leader
G. Padbury, B.S.A., M.Sc.	Party leader
H. P. W. Rostad, B.S.A., M.Sc., Ph.D.	Party leader
H. B. Stonehouse, B.S.A., M.Sc.	Party leader

Alberta Soil Survey (Edmonton)

W. W. Pettapiece, B.S.A., M.Sc., Ph.D.	Head of Unit
J. A. Brierley, B.Sc.	Party leader
G. M. Coen, B.Sc.	Party leader
G. T. Patterson, B.Sc., M.Sc.	Party leader
J. Tajek, Eng.	Party leader

British Columbia Soil Survey (Vancouver)

T. M. Lord, B.S.A.	Head of Unit
A. J. Green, B.S.A., M.Sc.	Party leader
D. E. Moon, B.Sc., Ph.D.	Party leader
C. J. Selby, B.Sc., M.Sc.	Party leader
K. W. G. Valentine, B.S.A., M.Sc., Ph.D.	Party leader
L. J. P. van Vliet, B.S.A., M.Sc.	Party leader

Soil Classification

J. A. McKeague, B.A., B.S.A., M.Sc., Ph.D.	Head of Section; Classification
C. A. Fox, B.A., M.Sc., Ph.D.	Micromorphology
P. E. M. Lévesque, B.S.A., M.S.A., Ph.D.	Organic soils
S. P. Mathur, B.Sc., Assoc. I.A.R.I., Ph.D.	Organic soils
G. C. Topp, B.S.A., M.S., Ph.D.	Physics and water
C. Wang, B.S.A., M.Sc., Ph.D.	Chemistry
G. Wilson, B.Sc., M.Sc., D.I.C.	Engineering
K. C. Wires, B.A.	Physical structure

Land Use and Evaluation

J. Dumanski, B.S.A., M.Sc., Ph.D.	Head of Section

D. R. Coote, M.S., Ph.D.	Degradation
J. Culley, B.Sc., M.Sc.	Water quality
R. DeJong, B.Sc., M.Sc., Ph.D.	Water use
E. Huffman, B.Sc., M.A.	Land use
B. Kloosterman, B.S.A., Ph.D.	Data system
K. B. MacDonald, B.S.A., M.Sc., Ph.D.	Evaluation
K. Switzer-Howse, B.Sc.	Information

Agrometeorology

J. C. van Schaik, M.Sc., Ph.D.	Head of Section
J. Boisvert, B.Sc., M.Sc.	Farm weather service research
A. Bootsma, B.Sc.	Agroclimatological resources
R. L. Desjardins, B.Sc., M.A., Ph.D.	Micrometeorology
L. M. Dwyer, B.Sc., M.Sc., Ph.D.	Environmental meteorology
S. M. Edey, B.Sc.	Applications
H. N. Hayhoe, B.Sc., M.S., Ph.D.	Biomathematics
A. R. Mack, B.S.A., M.Sc., Ph.D.	Remote sensing
D. W. Stewart, B.S.A., M.Sc., Ph.D.	Crop-weather modeling

Departures

J. I. MacDougall, B.Sc., B.Sc. (Agr.) Retired 30 December 1983	Party leader
A. A. Kjearsgaard, B.Sc. Retired 29 April 1983	Party leader
R. Simard, B.S.A., M.Sc. Transferred to Research Station, Lennoxville, 14 June 1983	Party leader

INTRODUCTION

The Land Resource Research Institute (LRRI) has responsibility for national programs in land resources and agrometeorologic services. The programs of the Institute include the national soil survey program, a supporting program in soil classification research, a program involving studies in land evaluation agricultural land use and soil degradation, and an agrometeorological program that includes agrometeorological services, farm weather service, crop-weather modeling, and crop information.

The Institute is organized on a regional basis, with soil survey units located in each of the provinces where cooperative survey work is carried out. The central group in Ottawa is responsible for national correlation and map production, and research in the various aspects of soil, water, and agrometeorological disciplines.

This report gives the outcome of the ongoing activities of the Institute during 1983. More complete information can be obtained from the Land Resource Research Institute, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

J. S. Clark
Director

INSTITUTE ROLES

The activities of LRRI include research, development, and services related to Canada's land resources. These activities not only support other research within the Research Branch but also provide information essential to policy and decision-making for regional and national levels of government, educational institutions, and agri-business. The Institute, in pursuit of these activities, provides leadership and is responsible for a number of national programs related to land, including those outlined below.

Soil inventory. Soil mapping is done by LRRI staff in cooperation with provincial and university personnel throughout the nation, and correlation provides quality control on soil maps and reports. Maps are prepared showing the distribution of soils and land capability for various potential uses.

Canada soil information system (CanSIS). Soil survey, soil management, crop yield, and cartographic data are stored in a computerized system so as to be available to users throughout Canada.

Soil taxonomy and interpretations. Improvements are developed in taxonomic and interpretive soil classification systems through research and integration of information from many sources.

Land evaluation. Data on soils, climate, agronomy, and economics are being integrated to develop improved methodology for predicting crop yield potentials and assessing the quality of the land resources of Canada for various uses.

Agrometeorological data archive. Agrometeorological data and processing services are provided.

Crop information system and agroclimatic resources. Procedures are developed monitoring the areal distribution of growing conditions and crop production prospects from meteorological, environmental, remotely sensed agriclimatic, and crop statistical data. Agroclimatic resources are assessed to provide information for efficient management of agricultural resources.

Committees. LRRI contributes to the integration of land-related and agrometeorology activities of Agriculture Canada and other federal and provincial agencies through participation in a number of committees. These include:

- Canada Committee on Land Resource Services (CCLRS) and the associated expert committees
- Provincial agricultural services coordinating committees and soil survey committees
- Canada Committee on Ecological Land Classification

- Interdepartmental Committee on Land Use
- Interdepartmental Committee on Water
- Geotechnical Committee of the National Research Council and the Peatland Subcommittee
- Canada Advisory Committee on Remote Sensing
- Committee on Great Lakes Water Quality
- Interdepartmental Committee on Air Surveys
- Canada Expert Committee on Agrometeorology
- Atlantic Advisory Committee on Agrometeorology
- Ontario Climate Advisory Committee
- Canadian Advisory Committee on Remote Sensing and associated committees
- Comité de Coordination des Services Agricoles du Canada (CCSAC)
- Commission d'agrométéorologie du Conseil des Productions Végétales du Québec (CPVQ)
- Atmospheric Environment Service (AES) Task Force on Standard and Non-Standard Climatic Data
- Canadian Committee on Climatic Fluctuations and Man
- Interdepartmental Committee on Telidon

INSTITUTE PROGRESS AND ACHIEVEMENTS

Soil resource inventory and mapping

Newfoundland. The Port-aux-Basques–Stephenville report was completed to the technical edit stage, as were reports for Green Bay, Gander Lake, Red Indian-Burgeo, and Terra Nova. The map and report on pedoclimatic zones and climatic mapping in the Bay St. George area (12B, 7 and 8) at 1:50 000 were reviewed. The key to the soils of western Newfoundland with official series descriptions has been completed.

Prince Edward Island. Three generalized maps (1:75 000) covering the province were submitted for publication. The first draft of the soil survey report for use with either the generalized or detailed map sheets has been completed. A transect study of soil map credibility in 43 locations was completed. Eight additional profile records were added to the CanSIS file.

Nova Scotia. Selected parts of Hants County were mapped (105 000 ha) and correlated. Kentville – Sheffield Mills Research Farms were mapped and sampled and the introductory sections of the report were written. In Kings County, 37 transects on four orthophoto sheets were completed for legend development and map unit verification. Part of one orthophoto sheet was mapped and 11 orthophoto sheets were correlated. Pictou County report was completed. Watertable wells and soil-temperature sites were maintained and monitored.

New Brunswick. A report for the detailed soil survey of Agriculture Canada's Senator Hervé J. Michaud Experimental Farm was completed. A detailed soil survey of Agriculture Canada's Fredericton Research Station Lower Farm was conducted and a report was completed for the whole farm. The Sussex Area land base study is in the process of being published. Field inventory work required to complete an exploratory soil survey of central and northern New Brunswick was conducted and a soils map and report are being prepared. A program of detailed resurveys in the Florenceville–Woodstock area was initiated; a preliminary legend was constructed and air photos have been assessed. Soil-temperature and moisture-regime monitoring was conducted. A tentative key for established New Brunswick soils was constructed.

Quebec. The completion of Saint-Hyacinthe and Richelieu maps and report was delayed and reallocation of tasks was necessary following the resignation of a pedologist and the unit clerk. A field trip was conducted in the Richelieu–Yamaska area and field guides were prepared and distributed to participants. Richelieu maps are under final revision and sections of the report are completed. Interim maps and an extended legend of Richelieu County were distributed to provincial and municipal agencies. Some 26 000 ha were mapped in Verchères and four map sheets are being compiled. Mapping of Chambly is completed and a detailed mapping legend is in preparation. Meetings with users were held to determine their information needs. Six selected soils were sampled for physical determinations. A soil temperature site was installed at the Saint-Hyacinthe Research Station. Soil sampling was carried out at the Port-aux-Saumons ecological center in order to verify and update soil information posters. A soil transect form was designed and used for mapping, and computer programs were written to produce statistical reports of map units and soil characteristics. The greater use of computers promises to improve the quality and efficiency of soil surveys. Survey of 20 peatlands was conducted as part of the peatland inventory project.

Ontario. Approximately 65 000 ha were mapped in the Niagara region and Elgin county. One preliminary soil map was completed for Grimsby and Lincoln townships in the Niagara region. Three preliminary soil maps and a legend for the Ottawa–Carleton region were finalized and commencement of final cartography is under way. The first draft of the soil report for Haldimand–Norfolk region is completed and editing has commenced. Report preparation for the Ottawa–Carleton region has commenced. Soil reports have been completed to the second-draft stage for the Timmins–Noranda–Rouyn map sheet, and revisions of the first draft are being made for Brant county. Editing of soil maps and legends by the soil surveyors has been carried out for the 13 sheets of the Haldimand–Norfolk region and for five map sheet areas of northern Ontario, as these maps progressed to final cartographic preparation. Printing of soil maps for Thunder Bay and Sudbury map sheets have been completed. Editing and printing of the soils report for Peterborough county were completed. The draft soil landscape map and legend for southern Ontario were completed and formed the basis for preparation of a predictive map for soil erosion potential. Demonstration of the ecological mapping program for forest management planning continued in the claybelt of northern Ontario. Application of the classification system for soil-management planning was enhanced through publication of a field guide to forest ecosystem classification for the claybelt and through the presentations of seven field-training courses for technical forestry staff of companies and of the Ontario Ministry of Natural Resources (OMNR). Initial studies were conducted in the Foleyet, Chapleau, and Gogama areas to extend the classification methodology into this different physiographic region. Reports on soil interpretations for woodland management were prepared for three regions of southern Ontario and for two intensive soils. Silvicultural courses were given to OMNR staff.

Manitoba. The detailed resurveys of approximately 150 000 ha were completed in Westbourne (D51) and portions of North Norfolk, Dufferin, and Grey municipalities (D60); rural lands surrounding nine towns and villages in southern Manitoba; three provincial parks; and the Pasquia Lake Basin. Soil reports were published for the Pasquia project (D63) and Swan River Townsite (D37). Compilation, correlation, and preparation of seven soil reports to publication stage have been completed for Rat River (D39), Sainte-Anne – La Broquerie (D49), Westbourne (D51), South Norfolk towns (D52), Montcalm–Rhineland towns (D53), Russell–Binscarth (D54), and Carman – South Central Escarpment (D17-R27). Data provided will greatly assist rural land planners, irrigation development planners working in support of the Prairie Farm Rehabilitation Act, and park planners in planning the development and management of their resources. The generalized soil map of Manitoba at a scale of 1:1 million is in production and will provide a valuable basis for generalized land evaluation and technology transfer. Two papers on the nature of Gleysolic and Gleyed Chernozemic soils have been compiled to publication stage. Pedological studies of these and Cryosolic soils were continued. Cooperative studies with the University of Manitoba on land evaluation and degradation were continued, as were soil-temperature and soil-water studies that are being carried out (*a*) to improve methods of assessing the productive capability of Manitoba soils; (*b*) to assess the impact of salinity and erosion by wind and water; and (*c*) to improve classification of irrigation soils.

Saskatchewan. Mapping was completed on approximately 198 900 ha in the Melville – Riding Mountain area and 230 000 in the Battleford area. Mapping was initiated on an additional 239 200 ha in the Battleford area. Reports were published for five municipalities and writing was completed on reports for an additional 14 municipalities. Report writing continued in the Weyburn–Virden and the Amisk – Cormorant Lake map areas. A computer-based data management system was developed and implemented for the soil survey laboratory. Maps were published showing the extent of the salinity and sensitivity to salinization of Saskatchewan soils, as well as the surface pH. Research on the nature of soil acidity and on the field response to liming was continued. Studies on the characterization and classification of clay soils and the nutrient-supplying power of minerals in selected Saskatchewan soils continued. Long-term monitoring of the hydrological properties of a typical prairie soil landscape was continued to establish the influence of the relationship between hydrology and the genesis and classification of Gleysolic soils and the formation of associated saline soils. A study on the sensitivity of Saskatchewan soils to acidic deposition was completed. Generalized soil and landscape maps were compiled for the northern agricultural fringe region of Saskatchewan.

Alberta. The Banff–Jasper biophysical report was published. The Warner County report has been reviewed, revised, and submitted for publication. Interim copies were made available to local administrative, assessment, and research personnel. About 150 000 ha were mapped in the Cardston survey and portions of the report have been drafted. Maps for 82I SW and SE were submitted to cartography. A report on water erosion potential in southern Alberta has been compiled and submitted for editing. Correlation activities saw field work done in Cardston and Paint earth, as well as the development of a computerized soil names file for Alberta with correlation of all unique symbol lists from past surveys. Land evaluations conducted in cooperation with provincial departments have resulted in a computer file of all survey information in Alberta on a quarter-section basis. This file has been merged with crop yield and Canada Land Inventory (CLI) data and is being analyzed.

British Columbia. The high-intensity Gulf Isles project resulted in production of digitized soil maps for Saltspring Isle and a soil report ready for editing by Research Program Service; edited soil maps for the Pender islands; a completed field survey of Mayne, Saturna, and Prevost Islands; and revised soil maps and legends for the Galiano–Valdez–Thetis report area. Information from these documents, often only in preliminary form, is available to answer requests for information to help choose suitable sites for plant nurseries, parks, septic tank fields, road locations, and ecological reserve studies. In the Cariboo area, publication of the Quesnel soil report and completion of manuscripts for the Horsefly and Barkerville areas have aided foresters and other resource managers at the regional planning level. Follow-up studies were carried out on identification and interpretation of interior wetland systems throughout the plateaus. In the northeast, soil maps and a manuscript report for Fort St. John – Dawson Creek were completed, and field checking and revisions were done under contract for the McAllister–Graham area in high-priority coal lands of the foothills. These lands, which are now under pressure from logging, strip mining, and hydroelectric power development, include sensitive fish and wildlife habitats. In addition to continuing the soil erosion studies in the Dawson Creek – Beaverlodge area, the Unit met a request from the British Columbia Ministry of Agriculture for detailed soils information and revised agriculture capability in the Pine valley west of Chetwynd. For the Power River inventory, maps and a manuscript report were completed and methods of computer-assisted map-unit definitions were published.

Yukon. During the first full year of operation, the unit was able to establish working relationships and sign letters of agreement with various federal and territorial agencies in the north. Field inspections were conducted and agricultural capability assessments were prepared for the Yukon Government at 25 development locations in the territory. Two months of field work was completed on a joint project with the Geological Survey of Canada in the McQuesten River area, providing the first widespread systematic descriptions of the pre-Wisconsin and unglaciated landscapes of central Yukon. Extension work has included holding seminars with various interest groups on soil impacts associated with land clearing, on methods of soil sampling, and on the principles of soil fertility. A soils field trip was conducted in association with the 34th Annual Alaska Science Conference. Plans and cooperative agreements have been finalized with the Yukon Government to carry out detailed soil surveys in the Whitehorse area next field season.

Northwest Territories. The soil section of the guide book for the Northern Yukon Territory – Mackenzie Delta field tour held in conjunction with the Fourth International Permafrost Conference was completed and the tour was conducted in the Inuvik–Arctic–Red–Mackenzie Delta area. In addition, an interim soil landscape map, with legend, for the Great Bear and Slave River project area was completed and the interpretation of

LANDSAT data for the southern Keewatin map area was carried out.

Ottawa. The plan for soil survey form 1 was published in the Proceedings of the Expert Committee on Soil Survey. Form 2 was revised and made operational in new projects. The CanSIS manual for describing soils in the field was revised and republished in both official languages. The soil-water methods manual was reviewed and revised. To classify the wet sands benchmark site, data were summarized and interpreted with respect to water table levels and the suitability of the soil-water regime classification. Small-scale maps were compiled for the Peace River area and for Alberta. Climatic and other soil properties were added to the extended legend for the Saskatchewan small-scale map. An aridity index for spring wheat grown in Saskatchewan was compiled. Section 400 (operations) of the soil survey procedures handbook was revised, and Sections 100 (soil surveys in Canada) and 200 (planning) were compiled. The book *Soil Surveys in Forested Lands* was completed and submitted for printing. *Soil Landscapes of Canada* was revised. Peatland inventory methodology studies were conducted in the St. Lawrence Lowland, Pacific Coast, Yukon, and Northwest Territories. A computerized wetlands registry was completed and is now operational.

Cartography. The Cartographic Unit has completed 103 maps for Agriculture Canada and Environment Canada. All maps planned for 1984–1985 have been digitized and are continuing on schedule. Sixteen special projects were initiated, with 10 being completed; displays were also prepared for the International Plowing Match and the Peatlands Conference. A total of 198 miscellaneous requests were handled for the Research Branch and an additional 43 requests were processed for the rest of the Department. A total of 123 maps were completed for the Canada soil information system and 288 derivative maps have been prepared to date.

Soil classification

Research by the Soil Classification Section supports soil inventory and interpretations and adds new information on soil properties and genesis. Progress is reported for each of the three projects: organic soils, mineral soils, and soil-water structure.

Organic soils. Following an examination of the Ontario capability rating system for organic soils for its validity and applicability on a national level, several modifications were suggested in a report. Need for research on wood and mineral sublayers was identified. The first objective was met through an extensive field survey. For the other, 12 different mineral sublayers of organic soils in various parts of Canada were identified and sampled for characterization.

A new system was developed for describing the micromorphology of organic soils at low magnification; it helps to bridge the gap between field macromorphology and microscopic studies at high magnification. Progress was made toward preparing a plant macrofossil atlas of organic soils by identifying typical macrofossil assemblages for nine sites on five different organic deposits, and by completing a study that showed micromorphology to be useful in ascertaining the degree of decomposition of an organic soil.

Research on reducing the subsidence of cultivated organic soils by about half through a particular regime of Cu fertilization was completed. It led to specific recommendations to growers by agriculture ministries of Ontario and British Columbia. New studies to develop soil tests for minor-element fertilizer requirements of organic soils were started.

European literature on shallow organic soils was searched in the United States and Canada and actual land use was studied. Sites were selected and an experimental approach was devised to compare two methods of studying the hydrological behavior of shallow organic soils under three management systems. A contract was prepared and granted to Carleton University. Work is being monitored. Other sites have been selected in Manitoba, British Columbia, New Brunswick, Quebec, and Ontario for use in further studies. A literature review on hydrological studies of shallow organic soils is being finalized.

Mineral soils. Long-term continuous potato cultivation is common in western New Brunswick. Studies indicated that this resulted in serious soil erosion. In about half of the studied sites (36 of 70) the solum became so thin, farmers were plowing into the C horizon (parent material). Some of the fields were abandoned as being no longer suitable for agriculture. The severe erosion has altered the classification of many affected soils to the highest categorical level.

Analysis of chemical data for more than 200 Canadian Podzolic soils showed that some criteria used in the U.S. system *Soil Taxonomy* for classifying Spodosols (genetically the same as Podzolic soils in Canada) were too restrictive. Proposals were made to change some of the chemical criteria of Spodosols.

Some limitations were found in the use of alkali-extractable organic matter as a basis of soil classification criteria; the ratio of soil to extracting solution, the centrifugal force, and some other factors significantly affected Ch-to-Cf ratios. Only through rigorous standardization and comparison among laboratories can this method become a useful basis for differentiating soil classes.

Preliminary data indicated that for a clayey marine soil near Ottawa the two soil properties (pH and organic C) had spatial relationships that could be characterized by a geostatistical technique known as the Kriging method. This showed that the Kriging method can be used in soil-spatial variability studies.

A chapter on engineering interpretation for the Norfolk–Haldimand Soil Survey Report was prepared, explaining to engineers and planners how to make use of the soil survey map and report for their purposes.

An updated soil analysis manual has been compiled in draft form. The number of requests for laboratory support and service from the Atlantic Provinces, Ontario, and the Ottawa sections of LRRI remained as high as last year (3000 soil and 400 water samples). Field services for the Ottawa sections of LRRI were provided to assist projects on crop modeling, soil drainage, groundwater pollution, and effects of pipeline construction on crop growth; greenhouse experiments included studies on fertilization of organic soils and on plant water uptake from soil.

Soil-water structure. Soil compaction in some fields continuously planted to corn could be detected rapidly and reliably by field observations of structure in the upper 30 cm of soil. Reduction of corn yields to as low as 50% of normal apparently resulted from compaction. Soil compaction was associated with a marked reduction in hydraulic conductivity (the ability of the soil to conduct water) and with shallow rooting.

Soil shrinkage is being investigated in order to determine changes in pore geometry as soil shrinks on drying and to determine the effects of shrinkage on water availability to plants. Preliminary data for a clay soil show that a major part of the "plant available water" was associated with shrinkage.

The application of the time-domain reflectometry (TDR) technique for measuring soil water was extended to measuring the quantities of rainfall infiltration under natural field conditions. The prototype TDR instrument developed under the pilot industry laboratory program (PILP) contract was modified to meet the market demands. This resulted in a single-purpose, more rugged instrument with options available by special purchases.

Land use and evaluation

The land use and evaluation program undertakes to develop improved techniques for integrating and interpreting soil climate, landform, agronomic, and economic data to evaluate the production potential and degradation hazards of land under alternate agricultural uses. Progress for each of the projects is as follows.

Canada soil information system (CanSIS). A microcomputer-based system has been acquired for the input of map data to the national cartographic file. This system consists of a self-contained stand-alone unit that can be installed regionally. The province of Ontario has acquired a unit, and action is under way to purchase stand-alone digitizing stations for Manitoba and Saskatchewan. The system provides preliminary local data-handling capability for soil maps at the same time as the data are input to CanSIS. In addition, the development necessary to transfer the cartographic production (CP) files, used to monitor cartographic activities, to a microcomputer has been completed. Transfer of the system is scheduled for 1984–1985. Currently, the files are stored at Datacrown and cost about $7000 a year for storage space and data manipulation.

All data in the national files of CanSIS have been made accessible to users across Canada in the form of one or a series of computerized relations in the RAPID data base management system. Data from the soil data (DETAIL) file and the performance management file have been transferred to regional users in direct machine-readable form. Reports have been prepared and distributed from the soil names file and from a merge of the soil names and soil data

(DETAIL) files. As a result, CanSIS is starting to play an active role in promoting national standards of consistency and correlation of land resource information.

Development and refinement of computerized legends for interpretive maps have continued in cooperation with Parks Canada and the Saskatchewan Institute of Pedology. In addition, legends have been developed for soil maps in New Brunswick and Ontario.

A new file, the wetlands registry, has been developed and implemented. Actual data from the 1983 field season is being used in the final testing phases.

A general CanSIS users' manual has been completed and reviewed; publication is approved and it will be submitted in 1983–1984.

Training has been provided in the form of intensive 1–4 week sessions for provincial, university, and federal personnel from the regions.

Land evaluation and crop production. Data compilation and interpretation have continued. The 1951–1980 climatic normals have been prepared, for updating the 775 map units in the land potential data base.

Available-water capacities have been estimated for soil profiles in Manitoba and Alberta. These data have been mapped on a scale of 1:1 million. The corresponding data for Saskatchewan have been combined with long-term climate data and used to calculate the soil-water contents at the heading of wheat at two levels of probability.

Compilation of data at the quarter-section level for a computerized soil resource and crop potential data base for Alberta has been completed. The data are being verified and will be augmented with yield and other related data. Preliminary estimates of wheat, barley, canola, and forage yields have been computed.

Agricultural resource areas are continuing to be assessed. At the request of the Planning Department of the Regional Municipality of Ottawa–Carleton, procedures for the identification of large-scale agricultural priority areas were established. The technique involves the preparation of a map showing land quality (soil capability for agriculture) as well as land-use intensity (land use systems). The map is then interpreted according to specific objectives. The technique permits the identification of core agricultural zones, underutilized land resources, and other combinations of soil and land use. Procedures are applicable at a detailed scale and will be used for regional planning purposes, provincial land use studies, and LRRI research in land use and evaluation.

A Statistics Can – LRRI data assessment study was completed for a report entitled *State of the Environment.* Manuscripts on land use systems methodology and on costs of underground services were prepared and submitted to journals. A bulletin was published on land-use systems in Ottawa–Carleton; a similar bulletin for Niagara has been prepared for publication.

The land evaluation contract program is still making progress. In Manitoba, development is well advanced in the preparation and testing of a procedure to model the yield of wheat based on land resource and climatic information. The procedure is needed to provide a consistent method for estimating crop production potential over a regional or provincial scale for input to land-evaluation models or regional quarter-section data bases. In tests against actual data the model predictions of yield, dry matter, and phenological stage are within 10% on well-drained sites, but differences from actual data range as high as 20% on sites with water tables near the rooting zone.

Field data for model testing and verification have been collected in association with this project. The data are stored in Manitoba and also in the performance management file of CanSIS. A full range of observations on the site, climate, crop phenology, and yield have been collected at 11 locations over 3 years.

A new 3-year contract has been negotiated with the University of Guelph to develop a prototype national land evaluation system for Canada. Advice and consultation for the duration of the contract have been solicited and obtained from the Regional Development Direcorate of Agriculture Canada, Lands Directorate, the Canadian Agricultural Research Council (CARC), the Canadian Federation of Agriculture, and the Canada Grains Council. A report describing the Ontario land-evaluation model was prepared by the contractor jointly with LRRI, and another was prepared by LRRI and presented to the Soil Conservation Society of America.

Land degradation. Data compilation and interpretation involved the preparation of the maps of soil-erosion risk for Ontario and part of the British Columbia Peace River region in British Columbia.

In a cooperative project with the Ontario Ministry of Agriculture and food the total annual cost of soil erosion to agriculture in Ontario has been shown to exceed $68 million. Soil-erosion studies at Ottawa and Guelph have shown that soil erodibility varies seasonally and is highest in early spring.

A display showing agricultural impacts on water and soil quality was prepared for the International Plowing Match.

Research and data collection activities include a program in which erosion is being monitored on an ongoing basis at 16 sites in the Peace River region. Annual erosion rates on fallow land ranging from 1 to 40 t/ha have been recorded.

Physical and economic data collected at agricultural drainage projects in eastern Ontario are being evaluated. A new study has been initiated in the Ottawa area on the effect of alternative tillage practices on compaction and water movement to drains.

A report was prepared in cooperation with other agencies on control of pollution from farmland in the Great Lakes Basin, and new research on phosphorus transport to streams has been initiated at the University of Guelph. Eleven research papers have been prepared as follows (four have already been accepted by journals): soil erodibility, one paper; erosion control, one paper; surface and subsurface drainage design, two papers; effect of drains on stream flow and water quality, two papers; environmental implications of manure storage and disposal, two papers; tillage and herbicide effects on soil structure, two papers; and assessment of acid rain effects on agriculture soils, one paper; five miscellaneous publications have also been completed.

Agrometeorology

Research and development within the Agrometeorology Section is concerned with characterizing weather and climate as it relates to agriculture in order to provide a quantitative basis for efficient use of Canada's limiting climate resources and to provide for more informed decision-making on weather-sensitive agricultural operations. Evidence is accumulating to suggest that we are likely to experience periods of climatic variability and possibly climate change due to increasing carbon dioxide levels. Research to increase our understanding and to develop methodologies to assess crop response to environmental factors is a prerequisite if food production in Canada is to effectively adjust to the possible complex environmental changes. Development of methodologies to assess agroclimatic resources for normal climate and for variable or changing climate conditions need increasing support. The growing cost of energy and the desirability of optimizing the application of chemical control for crop pests and disease make the development and dissemination of agrometeorological indices applicable for decision making for weather-sensitive agricultural operations an important priority.

Crop environment assessment. Studies carried out in cooperation with the Ontario Center for Remote Sensing showed the practical application of using a video color camera for acquiring inventory data on crops in land systems having a variety of crops on small hectorages. The procedure offers a cheap effective way of quickly obtaining imagery from small, local aircraft for immediate analysis on microcomputers and for manual or visual assessments. The use of this approach is in contrast to development being carried out in association with the Canada Center for Remote Sensing for rapidly assessing crop conditions over large areas during the growing season. This system has a ground resolution of 1 km and covers an area nearly the width of a province such as Saskatchewan. The initial use of land-system overlay maps on the imagery quickly delineates uniform areas of similar soil–climatic areas, within which assessment of the crop condition may be carried out.

Results from the yield-protein model showed a close correlation between estimated yields and recorded yields for combined groupings of crop districts ($r = 0.92$). Correlation for protein content was significantly good ($r = 0.75$) for the same groupings when tested for the years 1961 to 1978. During this period, the percentage decrease in protein content was greater than the percentage increase in yield after the effects of weather were removed. This suggests that the supply of nitrogen available for crop growth decreased from 1961 to 1978.

A microcomputer-based data acquisition system for flux density measurements was used to study crop–weather relationships. Independent measurements of CO_2 assimilation and transpiration showed that the efficiency of the mean daily water use can vary by a factor of three for corn depending on the amount of water available. CO_2 fluxes during most of the growing season showed daily and seasonal variations of CO_2 uptake. Its high correlation with intercepted solar radiation allowed definition of a potential (maximum) photosynthetic CO_2 flux against which the actual flux, affected by environmental impact, may be compared.

Maps are now available showing the average amount of water normally available in the soil for spring-seeded crops (wheat) on fallowland (1 May and 20 May). Maps, also, are available showing the reserves in the fall (1 October) after a crop of wheat and after a summerfallow period. These maps may be used to illustrate the seasonal cycling of water, water accumulation (fall–winter, summer–fallowland), and water depletion (cropping) for various soil climatic zones of Western Canada. These maps are complemented by others showing mean spring soil temperature on 1 May, depths, and the mean summer temperatures at several soil depths. These maps and others previously published on irrigation deficits provide a basis for describing the water and thermal conditions for spring-seeded cereals.

Agroclimatic resource assessment. Assessment of agroclimatic resources in the Atlantic Region continued for the purpose of improving production and management recommendations for forage crops in the region. Climatic analyses helped establish guidelines on optimum harvesting dates of forages and the critical fall rest period required for alfalfa to gain adequate winterhardiness and suitable conservation methods in relation to drying conditions experienced during summer months. This study will help promote improved forage yield and quality through timely harvesting and better conservation methods.

The computer archive of daily agrometeorological data for the Atlantic Region was expanded by the addition of 116 climate stations to the computer files. In most cases, data for the total period of record for each station as provided by Environment Canada was archived. Estimating of data for periods with missing records was performed under contract. This expansion of the climatic data archive will increase the capability of the Agrometeorology Section to conduct more detailed assessment of the climatic data available to scientists at research stations.

Preparation of freeze-risk maps continued for selected regions of Prince Edward Island where topographic and coastal influences induce variations in freeze risk at the farm level. This project is in cooperation with the P.E.I. Department of Agriculture and Forestry. Dates of last spring freeze, first autumn freeze, length of freeze-free period, and variation in nighttime minimum temperatures are all being mapped at a scale of 1:10 000. A total of 74 map sheets are being completed, covering about one-third of the total agricultural land area in the province. The information is to be used for extension to farmers for management decisions related to selecting land for production of frost-sensitive crops, adopting suitable planting and harvesting schedules, and predicting frost occurrences in farm fields for the purpose of implementing frost prevention methods.

Possible impacts of climatic change on potential dry matter yields of crops were studied in cooperation with the Crop Production Division of the Regional Development Directorate and the Land Use and Evaluation Section of LRRI. Estimates of potential yields of five crops were determined under contract for 22 different climatic-change scenarios and 755 soil map units covering all land areas in Canada, using a crop-growth model previously used to estimate present-day crop production potentials for land evaluation. This study will help define changes in crop yields that may occur if rising atmospheric carbon dioxide concentrations result in a warmer climate. Governments and the agricultural industry will then be in a better position to make more appropriate decisions in response to any anticipated change in climate.

Efforts continued toward improving our understanding of crop responses to the physical environment with the goal of developing improved crop growth and yield models. Data for a field experiment were obtained for the 2nd yr using three crops (corn, soybeans, barley) on four soil types. Leaf area development, biomass accumulation, and water status were monitored, and detailed phenological measurements were obtained. Greenhouse experiments were also conducted to study stomatal responses during onset of and recovery from water stress. Field and greenhouse data are being used to develop models of crop growth and yield, phenological development, and leaf expansion. These models will eventually improve our capability of assessing crop production potentials and predicting crop yields from climate–soil resource data and increase our understanding of the impact of crop management practices on the soil–climate regime.

Efforts to improve modeling of soil-water regimes continued. Improved models will increase our ability to predict crop yields, estimate potential crop production from soil–climate resource data, improve crop-production efficiency through better management, and characterize the soil climate for agriculture in general. The need for extensive laboratory measurements of soil-water characteristics for modeling purposes was reduced by modeling soil-water desorption curves from only a few measured soil water contents at specific tensions. Nitrogen leaching under various crop rotations in the prairies was explained in terms of a portion of the precipitation moving through macropores in the soil. The Hayhoe – de Jong soil moisture model was tested under native grassland conditions in the semiarid region of the prairies. The model satisfactorily predicted crop water use and soil water content in the root zone.

Operations management. The Agrometeorology Section is actively involved in research to develop and demonstrate the usefulness of indices and parameters that integrate weather and soil conditions into decision-making aids for agricultural production. As part of this project a series of weekly reports on current weather and soil-moisture conditions relative to the Prairie Provinces were made. Twenty soil-moisture evaluation reports were produced with over 400 manuscript maps for adaption using Telidon technology to the Grassroots videotex services. A crop-stress index was developed and tested as a method to provide for an improved indication of the potential impact on crop yields of inadequate soil moisture. Current computer weather data files for Ontario and the Prairie Provinces were updated on a weekly basis for use by regional agricultural researchers for near-real-time weather-based estimates of insect populations, disease development, and crop maturity. An evaluation was initiated of the potential of a microprocessor-based data logger to automatically record and transmit via telephone lines to a central computer critical environmental parameters. This system can potentially reduce manpower requirements and increase the availability of current weather data for computer updating of agrometeorological indices and models. Provincial and farm groups were visited in Ontario, Quebec, New Brunswick, and Nova Scotia with a view to improving local farm weather services through incorporation of agrometeorological indices related to pests, diseases, crop maturity, and hay-drying potential.

A project was initiated, in cooperation with the Commission d'agrométéorologie du Québec, to select and test a numerical soil-water model suited for application in a soil moisture evaluation project for Quebec and other locations in Eastern Canada.

Field monitoring of winter and spring environmental and soil conditions was continued to increase the data available to evaluate frost depth sensors and develop and test numerical models of soil temperature and freeze–thaw processes. A new capacitance method for determining frost penetration was successfully tested under field conditions. A computer analysis of 21 yr of Ottawa winter soil temperatures was completed and an empirical computer model for improving local soil temperature estimates was developed. A sonic snow-depth sensor was successfully tested in the laboratory.

New low-cost sensors that incorporate the principle of a miniature galvanic cell are being tested under field conditions for automated monitoring of leaf wetness. Leaf-wetting duration is a useful agrometeorological index to predict disease development and schedule control for fruit and vegetable production. Comparison studies against the standard instrument for wetting duration, the Hiltner dew balance, and a commercial resistance-type sensor are currently being conducted.

Seventy-eight three-dimensional plots were prepared showing the combined roadside and the combined field population of grasshoppers in Saskatchewan observed on a rural municipality basis for the years 1943 to 1981. The graphs provide a strong visual statement on the rapid growth and decline in grasshopper populations over time and give helpful insight into spatial interactions.

PUBLICATIONS

Research

Baker, T. H. W.; Davis, J. L.; Hayhoe, H. N.; Topp, G. C. 1982. Locating the frozen/unfrozen interface in soils using time-domain reflectometry. Can. Geotech. J. 19:511-517.

Brach, E. J.; Poirier, P.; Desjardins, R. L.; Lord, D. 1983. Multispectral radiometer to measure crop canopy characteristics. Rev. Sci. Instrum. 54:493-500.

Coote, D. R.; Ramsey, J. F. 1983. Quantification of the effects over 25 years of intensive cultivation on four soils. Can. J. Soil Sci. 63(1):1-14.

Culley, J. L. B.; Bolton, E. F. 1983. Suspended solids and phosphorus loads from a clay soil—II: Watershed study. J. Environ. Qual. 12:498-503.

Culley, J. L. B.; Bolton, E. F.; Bernyk, V. 1983. Suspended solids and phosphorus loads from a clay soil—I: Plot studies. J. Environ. Qual. 12:493-498.

Culley, J. L. B.; Phillips, P. A. 1982. Sealing of soils by liquid cattle manure. Can. J. Agric. Eng. 24(2):87-89.

De Jong, R. 1983. Soil water desorption curves estimated from limited data. Can. J. Soil Sci. 63:697-703.

Dickinson, W. T.; Pall, R.; Wall, G. J. 1982. Seasonal variation in soil erodibility. Am. Soc. Agric. Eng. Pap. No. 82-2573.

Dickinson, W. T.; Pall, R.; Wall, G. J. 1983. Identification of soil erosion and fluvial sediment problem. Am. Soc. Agric. Eng. Pap. No. 83-204.

Dinel, H. 1983. A technique for mounting and preserving peat soils monoliths. Can. J. Soil Sci. 63:753-755.

Dwyer, L. M.; Ivarson, K. C. 1983. Influence of woodlot floor topography on microbial decomposer distribution. Lolarctic Ecol. 6:101-106.

Fox, C. A. 1983. Micromorphology of an Orthic Turbic Cryosol—A permafrost soil. pp. 699-705 *in* Bullock, P.; Murphy, C. P., eds. Soil micromorphology. Vol. 2. Soil genesis. AB Academic Publishers, Berkhamsted, Great Britain.

Hayhoe, H. N.; Topp, G. C.; Bailey, W. G. 1983. Measurement of soil water content and frozen soil depth during a thaw using time-domain reflectometry. Atmosphere-Ocean 21:299-311.

Hayhoe, H. N.; Topp, G. C.; Edey, S. N. 1983. Analysis of measurement and numerical schemes to estimate frost and thaw penetration of a soil. Can. J. Soil Sci. 63:67-77.

Hayhoe, H. N.; Williams, G. D. V. 1982. Computing and mapping Thiessen weighting factors from digitized district boundaries and climatological station latitudes and longitudes. J. Appl. Meteor. 21:1563-1566.

Karrow, P. F.; Hebda, R. J.; Presant, E. W.; Ross, G. J. 1982. Late quaternary inter-till paleosol and biota at Guelph, Ont. Can. J. Earth Sci. 19 (9):1857-1872.

Keng, J. C.; Topp, G. C. 1983. Measuring water content of soil columns in the laboratory: A comparison of gamma ray attenuation and TDR technique. Can. J. Soil Sci. 63:37-43.

Lévesque, M. 1983. Un aperçu sur l'utilisation agricole des tourbières au Canada. *In* Symposium 82, A Symposium on Peat and Peatlands. Sheppard, Musial, and Tibbett, eds. Symposium at Shippagan, N.B. September 1982. pp. 78-108.

Lévesque, M. P.; Mathur, S. P. 1983. Effects of liming and pH on the growth and mineral nutrition of reed canary grass (*Phalaris arundinacea*) grown in two peat soils. Can. J. Soil Sci. 63:469-478.

Lévesque, M. P.; Mathur, S. P. 1983. The effect of using copper for mitigating histosol subsidence on: I. The yield and nutrition of oats and lettuce grown on Histosols, mineral sublayers, and their mixtures. Soil Sci. 135:88-100.

Major, D. J.; Brown, D. M.; Bootsma, A.; Dupuis, G.; Fairey, N. A.; Grant, E. A.; Green, D. G.; Hamilton, R. I.; Langille, J.; Sonmor, L. G.; Smeltzer, G. C.; White, R. P. 1983. An evaluation of the corn heat unit system for the short-season growing regions across Canada. Can. J. Plant Sci. 63:121-130.

Mathur, S. P. 1983. The lack of bactericidal effect of subsidence-mitigating copper soils. Can. J. Soil Sci. 63:645-649.

Mathur, S. P.; Bélanger, A.; Valk, M.; Preston, C. M.; Knibbe, E. N.; Sanderson, R. B. 1983. A study of onions grown in microplots on three organic soils each containing four levels of copper. Can. J. Soil Sci. 63:221-228.

Mathur, S. P.; Lévesque, M. P. 1983. The effects of using copper for mitigating Histosol subsidence on. 2. The distribution of copper, manganese, zinc and iron in an organic soil, mineral sublayer and their mixtures in the context of setting on threshold of phytotoxic soil-Cu. Soil Sci. 135:166-176.

Mathur, S. P.; Lévesque, M. P. 1983. Effect of liming on the yield, nutrition and copper status of potatoes, carrots and onions grown sequentially in two peat soils. Can. J. Soil Sci. 63:229-244.

Mathur, S. P.; Lévesque, M. P. 1982. The effects of using copper for mitigating Histosol subsidence on: II: The distribution of Cu, Mn, Zn, and Fe in an organic soil, mineral sublayers and their mixtures in the context of setting a threshold of phytotoxic soil Cu. Soil Sci. 135:166-176.

Mathur, S. P.; Valk, M.; Knibbe, E. N. 1983. The yield and nutrition of cauliflower grown on an organic soil field with four levels of copper. Commun. Soil Sci. Plant Anal. 14:1091-1099.

McKeague, J. A. 1983. Clay skins and argillic horizons. Pages 367-387 *in* Bullock, P.; Murphy C. P., eds. Soil micromorphology. Vol. 2. AB Academic Publishers, Berkhamsted, Great Britain.

McKeague, J. A.; Franzmeier, D. P.; De Coninck, F. 1983. Spodosols. Pages 217-252 *in* Wilding, L. P.; Smeck, N. E.; Hall, G. F., eds. Pedogenesis and soil taxonomy. Elsevier.

McKeague, J. A.; Grant, D. R.; Kodama, H.; Beke, G. J.; Wang, C. 1983. Properties and genesis of a soil and the underlying gibbsite-bearing saprolite, Cape Breton Island, Canada. Can. J. Earth Sci. 20:37-48

McKeague, J. A.; Topp, G. C.; Fox, C. A. 1982. Comments on soil porosity. Soil Sci. Soc. Am. J. 46:1122-1123.

McKeague, J. A.; Wang, C.; Coen, G. M.; de Kimpe, C. R.; Laverdière, M. R.; Evans, L. J.; Kloosterman, B.; Green, A. J. 1983. Testing chemical criteria for spodic horizons on Podzolic soils in Canada. Soil Sci. Soc. Am. J. 47:1052-1054.

McKeague, J. A.; Wang, C.; Topp, G. C. 1982. Estimating saturated hydraulic conductivity from soil morphology. Soil Sci. Soc. Am. J. 46:1239-1244.

Mustafa, M. A.; de Jong, R.; Hayhoe, N. H.; Topp, G. C. 1983. Intermittent infiltration and evaporation from soil columns. Can. J. Soil Sci. 63:303-314.

Patterson, G. T.; Wall, G. J. 1982. Within-pedon variability of selected soil physical and chemical properties in southern Ontario. Can. J. Soil Sci. 62:631-639.

Reynolds, W. D.; Elrick, D. E.; Topp, G. C. 1983. A reexamination of the constant head well permeameter method for measuring saturated hydraulic conductivity above the water table. Soil Sci. 136:250-268.

Ross, G. J.; Kodama, H.; Wang, C.; Gray, J. T.; Lafrenière, L. B. 1983. Halloysite from a strongly weathered soil at Mont Jacques Cartier, Quebec. Soil Sci. Soc. Am. J. 47:327-332.

Schuppli, P. A.; Ross, G. J.; McKeague, J. A. 1983. The effective removal of suspended material from pyrophosphate extracts of soil from tropical and temperate regions. Soil Sci. Soc. Am. J. 47:1026-1032.

Tarnocai, C. 1982. Soil and terrain development on the York Factory Peninsula, Hudson Bay Lowland. Nat. Can. 109:511-522.

Topp, G. C.; Davis, J. L.; Annan, A. P. 1982. Electromagnetic determination of soil water content using TDR: II Evaluation of installation and configuration of parallel transmission lines. Soil Sci. Soc. Am. J. 46:678-684.

Topp, G. C.; Davis, J. L.; Chinnick, J. H. 1983. Using TDR water content measurements for infiltration studies. Am. Soc. Agric. Eng. (ASAE) Proceedings on Advances in Infiltration. ASAE, St. Joseph, Michigan. pp. 231-240.

Topp, G. C.; Sattlecker, S. 1983. A rapid measurement of horizontal and vertical components of saturated hydraulic conductivity. Can. Agric. Eng. 25:193-197.

Wall, G. J.; Dickinson, W. T.; Greuel, J. W. 1983. Rainfall erosion indices for Canada east of the Rocky Mountains. Can. J. Soil Sci. 63:271-280.

Wang, C. 1982. Variability of soil properties in relation to size of map unit delineation. Can. J. Soil Sci. 62:657-662.

Wang, C.; Ross, G. J.; Gray, J. T.; Lafrenière, L. B. 1982. Mineralogy and genesis of saprolite and strongly weathered soils in the Appalachian Region of Canada. J. Marit. Sediments Atl. Geol. 18:130-138.

Wilson, G.; Wires, K. C. 1983. A device for accurate measurement of subsidence of organic soils. Can. J. Soil Sci. 61:169-172.

Wires, K. C.; Topp, G. C. 1983. Assessing the variability of Atterberg indices within the Dalhousie Soil Association (Brandon series). Can. J. Soil Sci. 63:485-494.

Miscellaneous

Acock, B.; Rapporteur, R. B.; Austin, K. J.; Boote, R.; Desjardins, R.; Eddleman, R. R.; Frey, N.; Gale, J.; Goudriaan, J.; Heichel, G. H.; Kimball, B. A.; Kramer, P. J.; Loomis, R. S.; Mauney, J. R.; Stonit, N. Plant growth and development. Chapter 5 *in* Lemon, E. R., ed. CO_2 and plants—The response of plants to rising levels of atmospheric carbon dioxide. Published by AAAS Selected Symposium 84.

Bootsma, A.; Suzuki, M. 1983. Critical fall rest period for alfalfa in the Atlantic Region. Agric. Can., Canadex 121.07.

Coen, G. M. 1983. Soil surveys and what they mean. Proceedings of the 20th Annual Alberta Soil Science Workshop. Faculty of Extension, University of Alberta, Edmonton, Alberta. pp. 50-58.

Coen, G. M.; Walker, B. D.; Taylor, W. S. 1982. Philosophical principles governing the development of the ecological methodology. Pages 157-159 *in* Holland, W. D.; Coen, G. M., eds. Ecological (biophysical) land classification of Banff and Jasper national parks. Vol. II. Soil and vegetation resources. Alberta Institute of Pedology Publication No. SS-82-44, University of Alberta, Edmonton, Alberta.

Coote, D. R. 1983. Soil degradation in Canada. An overview. Proceedings, B.C. Soil Degradation Workshop, 17-18 February. pp. 6-30.

Coote, D. R. 1983. Stresses on land under intensive agricultural use. Chapter 7, Folio No. 6, Lands Directorate, Environ. Can. pp. 227-257.

Desjardins, R. L. 1983. Quantification of sources and sinks of CO_2. Report on the technical meeting on sources and sinks of atmospheric CO_2 in northern latitudes. Published by the Atmospheric Environment Service. pp. 35-39.

Desjardins, R. L.; Dwyer, L. M.; Stewart, D. W. 1983. Agrometeorological techniques to characterize crop growth. Proceedings of the Fifth Symposium on Meteorological Observations and Instrumentation. Published by the Am. Meteorol. Soc. pp. 539-541.

Desjardins, R. L.; MacPherson, J. I.; Alvo, P.; Schuepp, P. H. 1983. Ground referencing and update on flight program for airborne CO_2 measurement. Proceedings of the 16th Conference Agriculture and Forest Meteorology, Ft-Collins, Colorado. pp. 74-76.

Dickinson, W. T.; Pall, R.; Wall, G. W. 1983. Seasonal variations in soil erodibility. Annual Meeting, Am. Soc. Agric. Eng., Chicago, Paper No. 82-2573. 15 pp.

Dickinson, W. T.; Pall, R.; Wall, G. W. 1983. Identification of soil erosion and fluvial sediment problem. Annual Meeting, Am. Soc. Agric. Eng., Delaware, Paper No. 83-804. 21 pp.

Dumanski, J.; Coote, D. R.; MacDonald, K. B. 1983. Agricultural land use concerns in Canada. Am. Soc. Agron. Special Publ. on Land Use.

Lévesque, P. E. M. 1982. Characterization and differentiation of peat materials in the context of peat soil classification. Proceedings of the organic soils mapping and interpretations workshop. Fredericton, N.B. September 1981. pp. 74-105.

Lévesque, P. E. M. 1982. Overview of the agricultural peatlands in Canada. Symposium 82. A symposium on peat and peatlands, Shippigan, N.B., September 1982. pp. 48-78.

Lord, D.; Dubé, P. A.; Desjardins, R. L.; Brach, E. J. 1983. Variabilité introduite dans des mesures de reflectances spectrales de couverts végétaux agricoles par les facteurs état du ciel et vent. Spectral signature of objects in remote sensing. Int. Coll., Bordeaux, France.

Harris, S. A.; Heginbottom, J. A.; Tarnocai, C.; van Everdingen, R. O. 1983. The Dempster Highway—Eagle Plain to Inuvik. Guidebook to permafrost and related features of the northern Yukon Territory and Mackenzie Delta, Canada. Guidebook No. 3. French, H. M.; Heginbottom, J. A., eds. Fourth International Conference on Permafrost, Division of Geological and Geophysical Surveys, Department of Natural Resources, State of Alaska, Fairbanks, Alaska. pp. 87-112.

Heginbottom, J. A.; Tarnocai, C. 1983. Mackenzie Delta and Inuvik. Guidebook to permafrost and related features of the northern Yukon Territory and Mackenzie Delta, Canada. Guidebook No. 3. French, H. M.; Heginbottom, J. A., eds. Fourth International Conference on Permafrost, Division of Geological and Geophysical Surveys, Department of Natural Resources, State of Alaska, Fairbanks, Alaska. pp. 113-146.

Hirose, T.; Cihlar, J.; Mack, A. R. 1983. Discrimination of Canadian crops with SAR plus VIR data. Eighth Canadian Symposium on Remote Sensing, Montreal, Quebec.

Holland, W. D.; Coen, G. M., eds. 1983. Ecological (biophysical) land classification of Banff and Jasper national parks. Vol. I. Summary. Alberta Institute of Pedology Pub. No. M-83-2. University of Alberta, Edmonton, Alberta. 193 pp., maps.

Holland, W. D.; Coen, G. M., eds. 1982. Ecological (biophysical) land classification of Banff and Jasper national parks, Vol. II. Soil and vegetation resources. Alberta Institute of Pedology Pub. No. SS-82-44, University of Alberta, Edmonton, Alberta. 540 pp., figs. and maps.

Hughes, O. L.; van Everdingen, R. O.; Tarnocai, C. 1983. Regional setting—physiography, geology and soils. Guidebook to permafrost and related features of the northern Yukon Territory and Mackenzie Delta, Canada. Guidebook No. 3. French, H. M.; Heginbottom, J. A., eds. Fourth International Conference on Permafrost, Division of Geological and Geophysical Surveys, Department of Natural Resources, State of Alaska, Fairbanks, Alaska. pp. 5-34.

Jones, R. K.; Pierpoint, G.; Wickware, G. M.; Jeglum, J. K. 1982. A classification and ordination of forest ecosystems in the great clay belt of northeastern Ontario: A framework for forest management. Proceedings of International Symposium on the Dynamics of Boreal Forest Ecosystems: Future research and management requirements.

Jones, R. K.; Pierpoint, G.; Wickware, G. M.; Jeglum, J. K.; Bowles, J. M.; Arnup, R. A. 1983. Field guide to forest ecosystems classification for the claybelt, site region 3E. Ontario Ministry of Natural Resources, Queen's Printer for Ontario. Toronto. 123 pp.

Mathur, S. P. 1982. Minor element fertilization of organic soils. Proceeding of the organic soils mapping and interpretations workshop. Fredericton, N.B., September 1981. pp. 166-171.

Mathur, S. P. 1982. Organic soil subsidence: A scan of conventional wisdom and current research. Proceeding Organic Soils Mapping and Interpretations Workshop, Fredericton, N.B., Agric. Can. pp. 139-156.

Mathur, S. P.; Bélanger, A.; Martel, P. 1982. Some problems encountered in agricultural usage of organic soils. Symposium 82. A symposium on peat and peatlands. Shippigan, N.B. September 1982. pp. 391-401.

Novak, M. D.; van Vliet, L. J. P. 1983. Degradation effects of soil erosion by water and wind. Soil degradation in British Columbia. Proceedings of the 8th meeting of the B.C. Soil Science workshop at Harrison Hot Springs, 17-18 February. Published by B.C. Min. Agric. Food.

Pettapiece, W. W.; Tajek, J.; Kjearsgaard, A. A. 1983. Soil erosion in Warner County. Proceedings of the 20th Annual Alberta Soil Science Workshop. Faculty of Extension, University of Alberta, Edmonton, Alberta. pp. 110-116.

Phillips, P. A.; Culley, J. L. B.; Leclerc, J. M.; Fox, A. C. A. 1983. Groundwater seepage from earthern manure storages in eastern Ontario. Paper No. 83-4570. Am. Soc. Agric. Eng., Chicago, Ill.

Phipps, M.; Dumanski, J. 1983. Application of information theory to the study of agricultural land use adjustment to natural environments. Proc. Applied Geog. Conf., Ryerson Polytech. Inst., Toronto, Ont.

Pollett, F. C.; Tarnocai, C. 1983. Summary of national workshop on peatland inventory methodology. Proc. of a Symposium on Peat and Peatland, NCIPS, ISBN 0-660-52102-4. pp. 237-266.

Stewart, R. B.; Dumanski, J. 1983. Assessing field crop production potentials. Can. Agric. 29:14-21.

Stewart, D. W.; Dwyer, L. M. 1983. A physiologically based model for estimating yield and percent protein of spring wheat in Western Canada. Sixth Conf. on Biometeorology and Aerobiology, 25 April 1983 and 16th Conf. on Agric. and Forest Meteorology, 26-28 April 1983, Ft. Collins, Colorado. Published by the Am. Meteor. Soc., Boston, Mass.

Tarnocai, C. 1982. Mapping of peatlands and organic soils on different scales of photos. Pages 171-186 *in* Rees, H. W.; ed. Proc. of the Organic Soils Mapping and Interpretations Workshop. Research Branch, Agric. Can.

Tarnocai, C. 1983. Peatland inventory methodology used in soil surveys. Pages 13-22 *in* Morgan, S. M.; Pollett, F. C., eds. Proc. of a Peatland Inventory Methodology Workshop. Land Resour. Res. Inst., Agric. Can. and Newfoundland Forest Res. Center, Environ. Can.

Tarnocai, C.; Rees, H. 1982. Field trip photo interpretation exercise. Pages 187-212 *in* Rees, H. W., ed. Proc. of the Organic Soils Mapping and Interpretations Workshop. Research Branch, Agric. Can.

Van Vliet, L. J. P.; Novak, M. D.; Keng, J. C. W.; Wood, R. C., eds. 1983. Soil degradation in British Columbia. Proceeding of the 8th Meeting of the B.C. Soil Science Workshop at Harrison Hot Springs, 17-18 February. Published by B.C. Min. Agric. Food.

Walker, B. D.; Corns, I. G. W.; Taylor, W. S.; Coen, G. M. 1982. Mapping methodology. Pages 159-167 *in* Holland, W. D.; Coen, G. M., eds. Ecological (biophysical) land classification of Banff and Jasper national parks, Vol. II. Soil and vegetation Resources, Alberta Institute of Pedology Pub. No. SS-82-44, University of Alberta, Edmonton, Alta.

Wang, C.; McKeague, J. A. 1983. Assessing soil structure degradation by field observations. Can. Agric. 29 (2):12-15.

Wang, C.; Rees, H. W. 1983. Soils of Rogersville–Richibucto Region N.B. Soil Survey Report No. 9. Research Branch, Agric. Can.

Research Program Service
Ottawa, Ontario

PROFESSIONAL STAFF

Administration

J. C. St-Pierre,[1] B.Sc. (Agr.), M.Sc., Ph.D.	Director
D. W. Friel	Administration and awards
W. L. Fettes	Branch liaison

Graphics

C. N. Halchuk	Art and design
W. G. Wilson	Photography

Scientific Editing

J. A. Perrin,[2] B.Sc.	Head of Section
D. M. Archibald, B.A.	Acting Head of Section
S. V. Balchin	Editing
N. Rousseau, B.A., M.A.	Editing
S. M. Rudnitski, B.Sc.	Editing
F. Smith, B.A.	Editing
J. M. Tomlinson, B.A., M.A.	Editing

Scientific Information Retrieval

J. Taky, B.A., B.Sc.	Head of Section
P. Beauchamp, B.Sc., M.Sc.	Herbicides
J. S. Kelleher, B.Sc., M.Sc., Ph.D.	Biological control
H. S. Krehm, B.A., M.A., Ph.D.	Fungicides and insecticides
C. D. Laing, B.Sc., M.Sc.	Inventory
J. Whelan, B.Sc.	Systems

Departure

R. Makowski, B.Sc., M.Sc. Educational leave, September 1983	Scientific information

---

[1] Appointed 5 July 1982. On secondment from Branch Headquarters.
[2] Seconded to Branch Executive.

INTRODUCTION

Research Program Service supports research and development in the Branch by maintaining computerized scientific and technical information systems, providing publications services, and administering Branch awards and international scientific exchange programs. The Service is divided into four sections: Administration, which contains the Awards, Branch Liaison, and Word Processing units; Graphics, which contains the Art and Design and the Photography units; Scientific Editing, which comprises English and French editors; and Scientific Information Retrieval, which contains the Biocontrol, Systems, Pesticides, and Inventory units.

The Scientific Information Retrieval Section completed the development of the Research Branch project outline system to supplement and improve upon the Branch's already close monitoring of progress in federal agri-food research. Phase III of the pesticide research information system was also completed. The Administration Section continued to administer the programs for operating grants, extramural research grants, and visiting fellowships and to coordinate international missions, visits, and exchange programs with the USSR, Brazil, Czechoslovakia, France, and Japan. News of happenings in the Branch was circulated to all staff members in 10 issues of *Tableau*, including a special issue on the Outlook Conference.

Graphics and Scientific Editing continued their high-quality production of Departmental and Branch publications and had a highly significant contribution in the preparation of publications, displays, and exhibits for the Outlook Conference.

Further information can be obtained from the Director, Research Program Service, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

Jean-Claude St-Pierre
Director

AWARDS AND BRANCH LIAISON

Research Program Service continued to administer the extramural research grants, operating grants, visiting fellowships, and scientific exchange programs during 1983.

Under the extramural research grants program, specific research projects are solicited from university scientists to augment current research programs. The program is the responsibility of a Departmental committee appointed by the Deputy Minister. In 1983, a total of 68 applications were received.

Operating grants are awarded to individual researchers at Canadian universities as contributions toward the costs of proposed research projects that will be of value to the agricultural industry. The selection committee is made up of three representatives from Agriculture Canada and seven from faculties of agriculture and veterinary science. In 1983, the committee received 307 applications.

The visiting fellowship program gives promising young scientists, from all over the world, the opportunity to work with distinguished researchers in their respective fields before embarking on careers in scientific research. The program is administered by the Natural Sciences and Engineering Research Council on behalf of Canadian government departments and agencies. Research Program Service acts as liaison between the Council and Agriculture Canada. In 1983, there were 337 applications for fellowships in this Department.

The Branch Liaison Unit arranged for 58 scientists to visit Branch establishments during the past year: eleven missions from France, three missions from the USSR, two missions each from the Federal Republic of Germany, Czechoslovakia, and New Zealand, and one mission each from the People's Republic of China, Brazil, Zimbabwe, the United Kingdom, Jamaica, and Egypt. The Unit also made arrangements for three scientists to visit the USSR, thirteen to France, and one to Czechoslovakia.

GRAPHICS

A wide variety of services in research photography and art production and illustration were provided to the Branch and other agencies within the Department. A total of 2098 jobs were handled, generating 45 714 pieces of work.

Demand for studio and field photography, slide production, and color printing increased by 73%, 53%, and 23%, respectively. Concurrently there was a decrease of 25%, 22%, and 10% in microphotography and macrophotography, black-and-white film processing, and black-and-white printing.

The addition of a second color enlarger and the acquisition of an automatic slide mounting and annotating machine allowed the photo unit to meet increased demand and to maintain an average turnaround time of about 7 days when only photo work was required. The overall turnaround time for all jobs done by Graphics was 10 days. Twenty-five seminar displays were produced in addition to those prepared for the Plowing Match and the Outlook Conference.

SCIENTIFIC EDITING

A total of 28 Departmental and 89 Research Branch publications were released during the year. Of these, 11 were priced publications. Some of the publications issued were *Proceedings of the National Forage Symposium 1981/Comptes rendus du Symposium national sur les cultures fourragères 1981*; *Grass genera of the Western Canadian cattle rangelands*; *Perennials in your garden/Les fleurs vivaces de votre jardin*; *Les insectes et arachnides du Canada. Partie 1. Récolte, préparation et conservation des insectes, des acariens et des araignées*; *The insects and arachnids of Canada. Part 10. The spittlebugs of Canada (Homoptera: Cercopidae)*; *The insects and arachnids of Canada. Part 11. The genera of larval midges of Canada (Diptera: Chironomidae)*; *Management and feeding of young dairy animals/Conduite et alimentation des jeunes bovins laitiers*; *Vomitoxin and zearalenone in animal feeds/Vomitoxine et zéaralénone dans les aliments du bétail*; *Recommended code of practice for handling chickens from hatchery to slaughterhouse/Code de pratiques recommandées pour la manipulation des poulets du couvoir à l'abattage*; *111 range and forage plants of the Canadian prairies*; *Home drying of fruits and vegetables/La déshydratation chez soi des fruits et des légumes*; *Pesticide research report*; 10 issues of *Tableau*; and 4 issues of the *Pesticide Newsletter*. Thirty-two bulletins were published in the Research Branch technical bulletin series, which provides timely technology transfer to specialized audiences.

Two special publications, *Merit Awards for outstanding contributions to research in food and agriculture/La Prime au mérite pour une contribution exceptionnelle à la recherche en agriculture et en alimentation* and *Agri-food research—a good investment/La recherche agro-alimentaire—un bon investissement*, were written and produced by Research Program Service especially for the Outlook Conference. *A Career in Agricultural and Food Research/Une carrière en recherche agro-alimentaire*, a foldout brochure, was released and distributed to universities, colleges, and secondary schools to promote interest in agri-food research among students.

SCIENTIFIC INFORMATION RETRIEVAL

In 1983, the Research Branch project outline system aimed at the improvement of management practices in the Branch was completed. Access to the system was provided country wide and updating was performed on a regular basis.

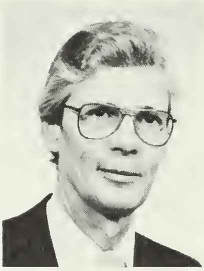
A new employment expansion development (NEED) program was accepted and four components of the pesticide research information system (PRIS) became fully operational. Thus Phase III of PRIS development was completed.

As part of a Branch *Compendium of Licensed Varieties—Potatoes/Compendium de variétés homologuées—Pommes de terre*, 53 varieties of potatoes were described. Twenty sheets available in nine languages are now ready for printing. This work was achieved in cooperation with the Food Production and Inspection and the Marketing and Economics branches.

The importation of insect parasites and predators as a service to Research Branch, Agriculture Canada, and Canadian Forestry Service, Environment Canada, was continued. In 1983, 22 shipments were received from 10 countries. There were over 630 000 individual specimens of hosts and parasites, including 500 000 of one species. Seven agricultural and three forestry projects were involved. Thirty-six shipments were sent from Ottawa for liberation or laboratory studies in seven provinces. There were 11 parasite species involved and a total of 38 000 individuals, including 34 000 of one species.

ATLANTIC REGION
RÉGION DE L'ATLANTIQUE

Dr. E. E. Lister



Dr. W. B. Collins

Mrs. S. M. Bowes

EXECUTIVE OF THE ATLANTIC REGION
L'EXÉCUTIF DE LA RÉGION DE L'ATLANTIQUE

Director General
Directeur général
E. E. Lister, B.Sc., M.Sc., Ph.D.

Program Specialist
Spécialiste en programmes
W. B. Collins, B.Sc. (Agr.), M.Sc., Ph.D.

Chief, Administrative Services
Chef, Services d'administration
S. M. Bowes

PREFACE

The Atlantic Region, with headquarters in Halifax, consists of four research stations, two experimental farms, and two substations. These research establishments serve the agricultural communities in New Brunswick, Prince Edward Island, Nova Scotia, and Newfoundland. In addition, the regional establishments make major contributions to national programs on potatoes, food processing, livestock feeds and nutrition, postharvest storage, and control of insects, disease, and weeds. In 1983, the region managed a budget of $21 million and employed 100 professionals to carry out its programs.

The soil management research program was directed toward the development of practical management technologies to cope with problems of erosion and physical constraints related to impermeable subsoils and to develop the potential of peatland resources in the region. Losses of soil and nutrients to erosion were documented during the year and management procedures for soils and crops leading to reductions in erosion losses are reported.

The livestock and livestock feeds research program was directed to the development of improved feeding and management systems, with emphasis on the utilization of locally produced feedstuffs for beef and dairy cattle, swine, and poultry operations in the region. Comparisons of systems for growing and fattening beef cattle are reported, as are implant comparisons and research on supplements for use with grass silage and hay in beef-calf diets. Results of studies on pasture forages and pasture management for dairy cattle and stocking densities for swine are presented. Research on the effects of both dietary management and dietary content on the performance and health of broiler chickens and meat breeder genotypes is also reported.

The objectives of the cereal research program were to develop and identify superior cultivars for the region for licensing and release, to identify and characterize the various *Fusarium* species that infect cereals in the region, and to elucidate the factors mediating hardiness in winter cereals. Breeding and evaluation results with spring and winter wheat, barley, winter rye, and oats are reported and new and promising cultivars are identified in the establishment reports. The effects of snow cover and winter duration on winter wheat performance are discussed, as well as the effects of the input of nitrogen, growth regulator-fungicide, and crop management.

The forage crops research program was directed toward the development of improved forage management practices and methods of storage and utilization. Results of forage establishment studies are reported, as is research on conservation practices and quality assessment. Progress in pest management and in the management of forages on peatland soils is also reported.

The objectives of horticultural crops research were related to the improvement of horticultural crop production, with special emphasis on the potato, through breeding, management, protection, nutritional, and physiological approaches. Progress is reported in the potato crop on breeding methodology, on the improved detection and diagnosis of disease, on advances in the control of insects and disease, and on the development of superior crop management practices for both seed and tablestock production. Progress is also reported in a variety of fruit, vegetable, and ornamental crops on new cultivar development, crop management refinements for increased productivity, and improved pest control strategies, with emphasis on biological and integrated pest management approaches. Biotechnology approaches are being adapted for rapid multiplication of a number of crops.

Processing technology and storage research is directed to improving the competitive advantage of regionally produced products in both domestic and export markets. Progress is reported on technology improvements in the processing of berry crops to ensure a superior product. Results of storage and storage technology studies are presented, which have led to improved storage capabilities with concomitant increases in the storage life of fruits and vegetables.

Significant staff changes in 1983 included the secondment of Mr. Romain Rioux from La Pocatière Experimental Farm to the position of acting Superintendent of the Hervé J. Michaud Experimental Farm.

Further information about our programs may be obtained by writing to the research establishment concerned or by addressing inquiries to Atlantic Region Headquarters, Research Branch, Agriculture Canada, 1888 Brunswick Street, Halifax, N.S. B3J 3J8.

E. E. Lister

PRÉFACE

La région de l'Atlantique dont le siège est à Halifax comprend quatre stations de recherches, deux fermes expérimentales et deux sous-stations. Ces établissements servent les collectivités agricoles du Nouveau-Brunswick, de l'Île-du-Prince-Édouard, de la Nouvelle-Écosse et de Terre-Neuve. En outre, les établissements régionaux collaborent aux programmes nationaux concernant la pomme de terre, la transformation des aliments, la nutrition des animaux, l'entreposage des récoltes, la lutte contre les insectes, les maladies et les mauvaises herbes. En 1983, la région a disposé d'un budget de 21 millions de dollars et employé 100 professionnels dans ses divers programmes.

Le programme de recherches sur l'utilisation des sols s'est orienté vers l'étude et l'application de techniques permettant de lutter pratiquement contre l'érosion et les obstacles physiques constitués par l'imperméabilité de certains sous-sols. On s'est attaché également à développer le potentiel économique que représente la tourbe dans ces régions. On a pu établir les pertes de sol cultivable et d'éléments nutritifs imputables à l'érosion durant l'année, et prévoir des mesures destinées à les réduire en améliorant les pratiques de culture et la protection des sols.

Le programme de recherches sur les bestiaux et sur leur alimentation a visé l'amélioration des procédés d'alimentation et de gestion des troupeaux, en insistant sur le recours à la production locale des aliments de bovins laitiers et de boucherie, des porcs et de la volaille. Des rapports ont été établis sur les mérites comparatifs de divers régimes appliqués à la croissance et à l'engraissement des bovins de boucherie et aussi des implants. Des études se sont poursuivies sur les suppléments à servir avec l'ensilage et les foins de graminées dans le régime des bouvillons de boucherie. On a présenté les résultats obtenus concernant diverses herbes de prairie, la gestion des pâturages pour le bétail laitier, ainsi que la densité des effectifs dans les élevages porcins. Des rapports ont également fait état des effets combinés des régimes alimentaires adoptés et de leur contenu nutritif sur le rendement et la santé des poulets à griller, et sur les génotypes de reproducteurs pour la chair.

Le programme de recherches appliquées aux céréales visait notamment à développer et à identifier des cultivars supérieurs destinés à l'usage régional que l'on offrirait au commerce après homologation. Un autre objectif était d'identifier et de décrire diverses infections fusariennes des céréales de la région et de déterminer la nature des facteurs incitatifs de la rusticité chez les céréales d'hiver. On a présenté un rapport sur les résultats obtenus de la sélection et de l'évaluation de blés d'hiver et de printemps, d'orge, de seigle d'hiver et d'avoine; les rapports des établissements ont mentionné la création de nouveaux cultivars prometteurs. Les discussions ont porté également sur les effets de la couverture de neige et de la durée de l'hiver sur le rendement des blés d'hiver ainsi que sur l'action de l'azote, des fongicides, des agents régulateurs de croissance et autres facteurs de la production sur ces mêmes blés.

Le programme de recherches sur les cultures fourragères poursuivait surtout l'amélioration des pratiques culturales applicables aux fourrages et aux procédés d'entreposage et d'utilisation. Des rapports ont fait état d'études sur l'implantation de cultures fourragères et de recherches concernant les procédés de conservation et l'appréciation de la qualité. On a mentionné également la lutte contre les ravageurs des récoltes et la culture de plantes fourragères en terres tourbeuses.

Les objectifs de la recherche appliquée aux cultures maraîchères portaient sur l'amélioration des plantes horticoles, avec une attention spéciale à la pomme de terre en ce qui concerne la sélection, les pratiques culturales, la protection des plantes et les aspects nutritifs et physiologiques. On peut y noter des progrès dans la méthodologie de la sélection, dans les mesures de détection et de diagnostic des maladies, dans la lutte aux insectes parasites et aux maladies et dans la mise au point de pratiques culturales nettement améliorées dans la production des tubercules de consommation et de semence. On relève également des progrès dans diverses cultures fruitières, maraîchères et de plantes ornementales, dans l'obtention de nouveaux cultivars, et des améliorations dans les pratiques culturales en vue d'accroître les rendements et l'efficacité de la lutte contre les agents ravageurs, en mettant l'accent sur le recours aux procédés biologiques dans le cadre d'une approche globale. Une méthodologie biotechnique est en voie d'adaptation pour la multiplication d'un certain nombre de plantes cultivées.

La recherche, dans le domaine des techniques de transformation et d'entreposage, vise surtout à développer les avantages concurrentiels des productions locales sur les marchés nationaux et d'exportation. À mentionner, les progrès réalisés dans les techniques de conservation des petits fruits qui assurent à ceux-ci une qualité supérieure. On présente les résultats obtenus d'études techniques sur l'entreposage qui ont permis d'élargir les possibilités offertes à cette opération tout en prolongeant la conservation des fruits et des légumes.

Parmi les mouvements de personnel les plus importants en 1983, il faut souligner l'affectation de Romain Rioux, de la ferme expérimentale de La Pocatière, au poste de surveillant en chef intérimaire de la ferme expérimentale Hervé J. Michaud.

Les personnes intéressées peuvent obtenir de plus amples renseignements sur nos programmes en écrivant aux établissements de recherches concernés ou en s'adressant au siège de la Région Atlantique, Direction générale de la recherche, Agriculture Canada, 1888 Brunswick Street, Halifax (N.-É.) B3J 3J8.

E.E. Lister

Research Station
St. John's West, Newfoundland

PROFESSIONAL STAFF

H. W. R. Chancey, B.S.A., M.S.A., F.A.I.C.	Director

Entomology

R. F. Morris, B.S.A., M.Sc., F.E.S.C.	Head of Section; Vegetable insects

Horticulture

B. G. Penney, B.Sc., M.Sc.	Vegetable crops

Plant Breeding and Pathology

K. G. Proudfoot, B.Agr., M.Agr.	Head of Section; Potato breeding
M. C. Hampson, B.Sc., M.Sc., Ph.D.	Plant diseases

Agronomy

A. F. Rayment, B.Sc., M.Sc.	Soil fertility and drainage

INTRODUCTION

The St. John's West Research Station is the center for agricultural research in Newfoundland and Labrador. The research program includes the development of drainage techniques for peat soils and the designing and adaptation of mechanical equipment for cultivating, fertilizing, seeding, and harvesting peat soil crops. Additional research involves potato breeding for resistance to wart disease and golden nematode, rutabaga breeding for resistance to clubroot disease, economic insect control, and vegetable nutrition and adaptation trials.

This report provides brief summaries of some of the results obtained in 1983. Further information, reprints of listed publications, and copies of previous reports can be obtained from the Research Station, Research Branch, Agriculture Canada, P.O. Box 7098, St. John's West, Nfld. A1E 3Y3.

H. W. R. Chancey
Director

ENTOMOLOGY

Cabbage root maggot

Rutabagas. Further field tests for tolerance of root maggot to fensulfothion (Dasanit) and carbofuran (Furadan) at St. John's and Wooddale showed that the former was ineffective at both locations. Carbofuran was effective at St. John's (74.3% control) but ineffective at Wooddale (49.0% control) in rutabaga trials.

Root maggot pupae collected at St. John's and Wooddale were screened for resistance to fensulfothion, carbofuran, and diazinon as adult fly populations by the London Soil Pesticide Laboratory. Both Newfoundland strains were as similar in susceptibility to each of the insecticides as was a susceptible London strain. Differences were not significant and there was no indication of organophosphate or carbamate resistance in the two strains. These results appear to support the theory that fensulfothion and carbofuran are biodegraded by soil microorganisms at both locations.

Additional insecticides evaluated for maggot control included turbofos (Counter), isofenphos (Amaze), and chlorofenvinphos (Birlane). Chlorofenvinphos and turbofos were most effective at both test sites, giving 99.5% and 97.6% control, respectively.

Late cabbage. Nine insecticides, including cypermethrin (Cymbush and Ripcord), cyfluthrin (Bay FCR 1272), and endosulfin (Thiodan), were tested at St. John's for control of imported cabbageworm, purple-backed cabbageworm and diamondback moth on late cabbage. Two applications of cypermethrin and two and three of cyfluthrin were more effective than single treatments. All pyrethroid applications were as effective as endosulfin and there were no significant differences in yield.

Blueberry leaf tier. Results of 11 treatments for control of leaf tier on lowbush blueberry stands at Colliers Ridge showed that the pyrethroid insecticides permethrin (Ambush), fenvalerate (Belmark), cypermethrin (Ripcord and Cymbush), decamethrin (Decis), and cyfluthrin (Bay FCR 1272) were as effective as azinophosmethyl (Guthion) in significantly reducing larval populations. Larval counts were taken before spraying on 7 June and after spraying on 13, 23, and 30 June and on 7 July. In biological studies, two hymenopterous parasites reared from leaf tier larvae collected at Mount Pearl and Avondale were subsequently identified as *Itoplectis quadricingulata* (Provancher) by the Biosystematics Research Institute. This would indicate that natural controls are widely distributed in the blueberry production areas, although current parasitism is very low.

PLANT SCIENCE

Field crops

Carrots. Urea, used as an N source for carrots grown on peat soil in NPK trials, was phytotoxic and reduced yields. Symptoms of stunting, chlorosis, and necrosis were observed during the growing season, and plots rated for severity of injury on 18 August showed increased injury with increasing rate of urea. Estimates of plants injured were as follows: 34% at 112 kg/ha, 57% at 224 kg/ha, and 74% at 336 kg/ha. Marketable and total yields were significantly reduced by increasing the urea level, and there was no response to P and K. A subsequent greenhouse experiment confirmed that urea injured carrots when added to peat soil. Plants were shorter, chlorotic, and produced lower yields than those receiving ammonium nitrate.

Blueberries. Weed control in recently burned lowbush blueberry plots was only fair following application of hexazinone with active ingredient (a.i.) at 0, 1, 2 kg/ha in all combinations with atrazine with a.i. at 0, 4, 8 kg/ha. Herbicide effectiveness was reduced because *Cornus canadensis*, the dominant weed species, was not susceptible. Both herbicides controlled grasses, but atrazine was more effective at the higher rate.

Blueberry plants grown from seed of high-yielding select clones obtained from Kentville Research Station, and transplanted to peat soil at Colinet in 1979, failed to achieve much growth prior to pruning by burning in 1983. At the end of the growing season, 33.9% of the surviving clones had spread sufficiently to occupy approximately 900 cm^2 each.

SOIL SCIENCE

Peat soils

Fertility. A 4-yr study was concluded on the response of timothy to N and P maintenance applications on stands established on peat soil. When response curves were arranged in families, certain patterns emerged that have been useful for interpreting results. For example, in a family of phosphorus curves involving different nitrogen levels, successive yield limitations resulting from step-wise reductions in N fertilizer resulted in successive increases in the Mitscherlich *C* values. Also, in a comparison between years, yield limitations resulting from a moisture deficit in one year caused a similar increase in the *C* value. These patterns helped to derive the best *C* value, representing optimum conditions, and also to better rationalize fertilizer recommendations based on soil test results.

The patterns observed in response curves to N were quite different to those of phosphorus, retaining a greater degree of constancy in *C* value under the different degrees of limitation, thus making them more difficult to interpret. As a consequence, nitrogen will be further investigated in studies planned on potassium response.

Data obtained from a 3-yr experiment on Cu and Mo content of forage have been reexamined in the light of the Cu-to-Mo ratio. Fertilization levels of Cu and Mo approximating common practice of the time were found to induce ratio values of about 3.5 in clover tissue and 7.5 in grass tissue, which taken together fell in the range reported as inducing molybdenosis in sheep. It is now believed that in some previous experiments the level of Mo may not have been great enough to counteract the levels of Cu provided therapeutically in the form of rumen-implanted bullets, so that Cu toxicity resulted. A widening of the Cu-to-Mo ratio in the fertilizer from 15 to 100, supplying Cu at 1.4 kg/ha and Mo at 0.014 kg/ha initially and half those rates subsequently, should eliminate molybdenosis as a problem on peatland pastures of the type investigated.

Machinery. A special forage trailer was designed and constructed for use on peat soil, in conjunction with continuing experiments on forage-harvesting systems. The trailer was constructed with very low ground clearance, so that when the wheels (three to each side) sink to a depth of 10 cm, the specially constructed bottom skids along the peat surface. Ground pressure is relatively high with wheel support alone (37.2 kpa loaded), but it is reduced to 4.8 kpa when resting on the bottom. Construction costs were about half of those for an equivalent tracked trailer.

PLANT BREEDING AND PATHOLOGY

Potato wart disease

Pathogenesis. Potato sprouts 15–18 cm long were inoculated by aqueous immersion and became infected at each node. Wart pieces frozen for 7 days at −10°C caused most infection, while $CaCl_2$ stimulated most infection. Best wart production from aqueous immersion inoculation was at pH 5.0; least successful results were associated with higher pH levels, the reverse of those obtained in field experiments. The difficulty in obtaining parallel results in field and pot experiments bears out similar findings by other workers attempting in vivo wart production.

Sporangial examination. Germination vesicles increased in number over time when wart samples were incubated in moist sand. Vesicles, which protrude from wart sporangia prior to zoospore release, increased in frequency exponentially over a 5-wk period, but were rare at 3 wk. Release of vesicle content has not been fully observed as yet.

Viability. In an attempt to find a chemical marker for detection of viability in wart sporangia, samples in a nuclear magnetic resonance (NMR) experiment showed an increase in inorganic phosphate content after heat treatment. Parallel work on infiltrating sporangia with ATP-ase showed little promise, but extracted sporangial contents displayed a weak interaction with the enzyme. Results suggest that detection of viability can be related to phosphorus content of sporangia.

Breeding potatoes for resistance to wart and potato cyst nematode

The blue-skinned wart-resistant potato selection N647-24 was licensed as the cultivar Brigus. Heavy crops of well-shaped tubers substantially free from scab and maturing earlier than Blue Mac were recorded. Seed stocks are being multiplied at the Provincial Seed Potato Farm in anticipation of grower demand.

Selection N664-127 (wart and nematode resistant) again yielded well in trials and demonstration plots. Leaf rolling symptoms observed in 1982 appear to result from infection by leaf roll virus and *Rhizoctonia* fungus. Stocks free of symptoms have been obtained and seed is being increased.

The wart resistant white-fleshed selection N961-9 was highest yielding in a trial of red- and pink-skinned selections and also had the highest specific gravity. N961-9 was derived from crossing the wart-susceptible cultivar Chieftain with a wart-resistant selection from South American andigena material. Two blue-skinned selections, N787-4 and N1051-1, had high yields, high specific gravity, and resistance to nematodes. N787-4 has high field resistance to all wart races, and Nl051-1 appears to have race-specific resistance. Commercial evaluation of these selections will be made in 1984.

Rutabaga breeding

Roots of more than 80 cultivars and breeding lines, most obtained from germ plasm banks in Britain, were assessed for susceptibility to root maggot injury with the use of single-row 5-m plots. In general, green-topped roots were much less susceptible to injury than purple-topped ones, but the most resistant roots were those of the purple-topped cultivars Vige and Chignecto.

A number of cultivars were grown without boron fertilizer and six roots of each cultivar were cut longitudinally and assessed for symptoms of boron deficiency. In addition to the normal brown heart associated with boron deficiency, a number of roots had hollow centers, also associated with boron deficiency. Among the cultivars showing the least number of symptoms were the old British cultivars Up to Date and Market Giant, a New Zealand cultivar Nye, and the German cultivar Frankenstolz. The Norwegian cultivar Vige, the German cultivar Viola, and the British cultivars Garden Swede and Pentland Harvester were extremely susceptible. Roots grown without boron fertilizer also appeared to be more susceptible to root maggot injury.

PUBLICATIONS

Research

Hampson, M. C.; Coombes, J. W.; Murphy, A. M. 1983. Procedures for isolating populations of whole and fragmented resting sporangia of *Synchytrium endobioticum* (Schilb.) Perc. from potato tissue for electron microscopy and chemical analyses. Plant and Soil 72:49-55.

Hampson, M. C.; Porter, G. M.; Morris, P. J.; McRae, K. B. 1983. Identification of field loci with potential for biological control of the potato wart disease. Can. J. Plant Pathol. 5:43-48.

Miscellaneous

Hampson, M. C. 1982. Investigations of potato wart disease. Can. Agric. 27(3):4-7.

Hampson, M. C. 1983. Potato canker in Newfoundland. Pages 71-78 *in* N. Hennessey, ed., The Newfoundland and Labrador Environment: A collection of case studies.

Morris, R. F. 1983. Introduced terrestrial insects. Pages 551-591 *in* G. R. South, ed., Biogeography and ecology of the Island of Newfoundland.

Proudfoot, K. G. 1983. Potato wart disease: A potential threat to potato production. Pages 152-153 *in* Research for the potato in the year 2000. Proceedings International Congress 1982, International Potato Center, Peru.

Rayment, A. F.; Bailey, R. T. 1983. Peatland forage and general purpose trailer. Peat News 5:17-20.

Research Station

Charlottetown, Prince Edward Island

PROFESSIONAL STAFF

L. B. MacLeod, B.Sc. (Agr.), M.Sc., Ph.D., F.C.S.S.S.	Director
C. B. Willis, B.Sc. (Agr.), Ph.D.	Assistant Director
D. A. Hutchinson	Administrative Officer
B. Stanfield,[1] B.S.A., M.S.A., M.L.S.	Librarian
M. B. Bourdon, D.Journ.	Information Officer
J. R. Enman,[2] B.Sc. (Agr.)	Productivity Enhancement Program Biologist

Cereals

J. A. MacLeod, B.Sc. (Agr.), M.Sc., Ph.D.	Head of Section; Forage and cereal nutrition
A. J. Campbell, B.Eng.	Agricultural engineering
M. R. Carter,[3] B.Sc. (Agr.), M.Sc., Ph.D.	Soil tillage
L. M. Edwards, B.Sc., M.Sc., Ph.D.	Soil management
U. C. Gupta, B.Sc. (Agr.), M.Sc. (Agr.), Ph.D., F.C.S.S.S., F.A.S.A., F.S.S.S.A.	Soil and plant micronutrients
H. W. Johnston, B.Sc. (Agr.), M.Sc., Ph.D.	Cereal diseases
R. A. Martin, B.Sc., B.Sc. (Agr.), M.Sc., Ph.D.	Cereal diseases
H. G. Nass, B.S.A., M.Sc., Ph.D.	Wheat breeding, cereal physiology
J. D. E. Sterling, B.S.A., M.Sc.	Barley breeding

Forage and Livestock

L. S. THOMPSON, B.Sc. (Agr.), Ph.D.	Head of Section; Forage, cereal, and potato insects
R. G. ANDREW,[4] B.Sc. (Agr.)	Agricultural economics
T. M. CHOO, B.Sc., Ph.D.	Red clover breeding
H. T. KUNELIUS, B.Sc., M.Sc., Ph.D.	Forage physiology and management
P. R. NARASIMHALU, B.Sc., B.V.Sc., M.S., Ph.D.	Forage quality and utilization
M. SUZUKI, B.Sc., Ph.D.	Forage and cereal biochemistry and physiology
C. B. WILLIS, B.Sc. (Agr.), Ph.D.	Forage diseases
K. A. WINTER, B.Sc. (Agr.), M.Sc., Ph.D.	Cattle nutrition

Horticulture and Tobacco

J. A. CUTCLIFFE, B.Sc. (Agr.), M.Sc.	Head of Section; Vegetable nutrition and management
W. J. ARSENAULT, B.Sc. (Agr.)	Tobacco management and nutrition
J. A. IVANY, B.Sc. (Agr.), M.S., Ph.D.	Vegetable, potato, and cereal weed control
J. KIMPINSKI, B.S.A., M.Sc., Ph.D.	Nematology
J. G. McDONALD, B.Sc. (Agr.), M.Sc., Ph.D.	Potato virus diseases
H. W. PLATT, B.Sc., Ph.D.	Potato diseases
D. C. READ, B.Sc. (Agr.), M.Sc., Ph.D.	Pesticide bioactivity, vegetable insects
J. B. SANDERSON, B.Sc. (Agr.), M.Sc.	Potato management and nutrition
J. G. STEWART,[5] B.Sc., M.Sc.	Entomologist in training
R. P. WHITE, B.S. (Ed.), M.S., Ph.D.	Corn and potato nutrition and management, soil chemistry

VISITING SCIENTISTS

M. Huber-Reinhard, Dipl. Inc. Institut fur Pflanzenbau, University of Bonn, Federal Republic of Germany	Plant biochemistry
A. V. Sturz, B.Sc., Ph.D. Natural Sciences and Engineering Research Council visiting fellow	Cereal diseases

---

[1] Seconded from Libraries Division, Finance and Administration Branch.

[2] Appointed 1 March 1983.

[3] Transferred from Vegreville Experimental Farm, 14 February 1983.

[4] Appointed 21 March 1983.

[5] Appointed 29 August 1983. On educational leave at the University of Guelph, Guelph, Ont., as of 29 August 1983 for an indefinite period.

INTRODUCTION

The Research Station at Charlottetown has Atlantic Region responsibility for research on the production and utilization of livestock feed crops (forages, cereals, protein), tobacco, and certain vegetable crops (cole, peas) grown for processing. Emphasis on potato research is in the areas of nutrition and management for processing and table potatoes, but especially for small whole-seed potato production. Research is also conducted on disease evaluation and control, and on postharvest testing by enzyme-linked immunosorbent assay (ELISA) for virus content of potatoes destined for the domestic and export seed markets.

Dr. T. M. Choo is on a 1-yr work transfer at the University of Kentucky, studying interspecific hybridization techniques. Dr. K. A. Winter has completed a 1-yr work transfer on forage-based beef production at the Agricultural Institute in Ireland.

Four positions were staffed during the year: Dr. Martin R. Carter, formerly at Vegreville, Alta., joined our staff as a research scientist in minimum tillage. Rollin Andrew was hired as a research economist to develop agricultural production models (crops and livestock) and for econometric evaluation of agricultural systems. John Enman was hired as a productivity enhancement program (PEP) biologist to provide closer liaison between research and regional development activities. Jeff Stewart was hired as an entomologist in training and is currently enrolled at the University of Guelph in a Ph.D. program in integrated pest management.

Dr. Michael Huber-Reinhard, Institute of Plant Production, University of Bonn, Federal Republic of Germany, under the Canada–Germany Science and Technology Agreement, conducted a 3-mo research program at the Charlottetown Station with Dr. M. Suzuki on the chemistry of fructosan in winter wheat and its relation to winter survival. Dr. A. V. Sturz, Natural Sciences and Engineering Research Council, completed a 2-yr postdoctoral fellowship on the epidemiology of *Fusarium* diseases of cereals.

The upcoming year, 1984, will be the 75th anniversary of the establishment of the Charlottetown Experimental Station in 1909.

This report includes brief summaries of some of the research completed in 1983. More detailed information may be obtained by referring to the Station's Research Summary, which is published annually, or by contacting the Research Station, Research Branch, Agriculture Canada, P.O. Box 1210, Charlottetown, P.E.I. C1A 7M8.

L. B. MacLeod
Director

CEREAL CROPS

Breeding and testing

Doubled haploids. It was shown that with the aid of one or two linked marker genes, the location of a polygene can be identified from a doubled-haploid population derived from a cross of two diploid inbred parents.

Barley. The high yielding, early maturing, two-row feed-type barley AB53-4 has been licensed as Micmac in honor of the native Indian people of the Maritime region. The variety has performed well in the Maritimes, Ontario, and Quebec. Rodeo, another newly licensed two-row feed-type barley developed by Ciba-Geigy Seeds Ltd., Ontario, features high yield and good resistance to lodging, and has good production potential in the Maritime Provinces. An intensive search has begun at Charlottetown for parental material with good resistance to net blotch, *Pyrenophora teres* Drechs., the region's major barley disease. Early indications are that significant improvements through breeding should be possible.

Spring wheat and spring triticale. Spring triticale lines were equal to or better than spring wheat material in all tests. Triticale 1, Triticale 3, and Juanillo 97 have shown good yield potential. Juanillo 97 matures considerably later than the other two triticales and spring wheat check cultivars. Triticale 1 and Triticale 3 have similar maturity to Vernon and Milton, and are short-strawed with good lodging resistance. AW 62 and AW 70 are promising Charlottetown spring wheat lines that have exceeded Milton and Vernon in yield.

Winter wheat and winter triticale. Borden, a winter feed wheat cultivar developed at the Charlottetown Research Station, was released to pedigree seed growers. Borden is a hardy cultivar that has consistently outyielded Lennox and Valor in 4 yr of tests in the Atlantic Region. Its reaction to most diseases is similar to that of Lennox and Valor, and it has slightly stronger straw. The winter triticale GWT 3 has superior yield to winter wheat cultivars, strong straw, and is tolerant of powdery mildew and *Septoria*. However, GWT 3 is susceptible to snow mold and is slightly less hardy than Lennox and Valor.

Winter rye. The 3-yr yield performance of the Polish cultivar Nowe has been superior to check cultivars Kustro and Animo.

Winter rapeseed. Winter rapeseed has been evaluated for 2 yr and has shown surprising performance in New Brunswick and Prince Edward Island. A limited number of European cultivars have been tested. The crop must be seeded in August to ensure sufficient plant development for adequate survival through the winter. Yields have been good at 1.5–2 t/ha.

Oats. Kamouraska, an oat variety developed at the Research Station in Sainte-Foy, Quebec, has performed well under extensive testing in the Maritime region. It is being placed on the list of recommended varieties for the region, where its yield, resistance to lodging, and kernel size have been very favorable.

Freezing resistance of winter cereals. Lennox winter wheat and Kodiak fall rye were the most resistant cultivars. GWT 3 triticale was not as resistant as fall rye or as some of the winter wheat cultivars. The high freezing resistance of Kodiak fall rye may partly explain its high resistance to snow mold in comparison with Kustro and Srebrne.

Management and nutrition

Growth regulators on Lennox wheat. Neither PP-333 (ICI Limited, U.K.) nor abscisic acid increased winterhardiness or freezing resistance of winter wheat. The application of PP-333 resulted in retardation of growth and less lodging of winter wheat. This growth regulator was also effective in controlling a wide range of weeds, such as corn spurry, shephard's purse, and fescue spp.

Sulfur nutrition of cereals. Application of S did not affect the yield of wheat or barley grain. In tissue of plants in the boot stage, S concentrations as low as 0.11–0.13 $\mu g/g$ appeared to be sufficient. Gypsum was found to be most effective in increasing S uptake by plants.

No-till forage corn. A no-till corn planter was constructed economically by attaching two fluted colters and weights in front of a two-row, three point hitch Ford corn planter. Forage corn planted into cereal stubble using this no-till planter was equal to corn planted in tilled soil over 2 yr. Excellent weed control in no-till corn was obtained with a preplant application of glyphosate at 1.4 kg/ha and an application of atrazine before emergence at 2.5 kg/ha.

Diseases and insects

Fusarium. Little or no *Fusarium* infection of barley or wheat heads was detected prior to head emergence. After head emergence there was a continual increase in number of heads infected. Application of propiconazole as weekly and biweekly sprays reduced symptom expression by 45% on wheat. Yield increases from propiconazole treatments were 31% and 34% for wheat and barley, respectively. Yield benefit was not, however, totally a result of effects on *Fusarium* infections of the head.

Pyrenophora teres. Conidial release of *P. teres* in barley followed a diurnal periodicity, with the peak release periods between 10:00 a.m. and 4:00 p.m. Significant airborne spore loads in the field were detected only when the foliage was dry. Major spore release episodes occurred 2–5 days after a period of leaf wetness that was 16 h or longer. Cumulative spore totals followed closely the disease progression curve, after a short lag.

Effect of seed treatments on the intensity of net blotch on barley. Use of fungicide seed treatments significantly reduced the intensity of net blotch on barley, with a reduction of 68.9% and 43.3% on the penultimate leaf from triadimenol and maneb treatments, respectively (Growth Stage 3, Zadok's). Apparent infection rates were not effective in determining relative efficiency of seed treatments in control of net blotch, possibly as a result of changes to initial inoculum levels. A yield-loss assessment study indicated a 13–15% reduction in yield of Volla barley, associated with net blotch symptoms based on 3-yr means of symptom-to-yield correlations.

European corn borer. Good control of the European corn borer, *Ostrinia nubilalis* (Hübner), was obtained with granular (G) soil or foliage spray treatments (emulsifiable concentrate—EC) with several insecticides including cypermethrin (G or EC), deltamethrin (EC), permethrin (G), and quinalphos (G). In 4 yr of testing, despite good borer control each year, grain yields were improved significantly in only 1 yr with insecticide treatment and only in plots treated with cypermethrin granules. Therefore, the corn borer is not considered an economically significant pest of corn in Prince Edward Island.

FORAGE CROPS

Red clover testing

Cultivar–environment interactions in red clover. A study on red clover showed that because of a large variance in cultivar–environment interaction, at least 15 location-years were required in order to detect a yield difference of 6% in double-cut cultivar evaluation trials in Atlantic Canada.

Evaluation of varieties and species

Adaptability of alfalfa to wet soils. Michigan 80-16 alfalfa demonstrated better adaptability to wet soil than Iroquois or Saranac alfalfa in a poorly drained field. However, none of the alfalfa cultivars demonstrated resistance to flooding.

Adaptability of legumes to acidic soils. Ladino clover, Maku big trefoil, and Leo birdsfoot trefoil were evaluated in a field with acidic soil (pH 4.8). Ladino clover was well established in the seeding year, whereas big trefoil and birdsfoot trefoil plots were severely infested with weeds. Big trefoil demonstrated excellent performance after the second cut in the 2nd yr.

Management and nutrition

Forage zonation mapping in the Atlantic region. The Atlantic region was divided into zones with distinctly different climatic characteristics. Three sets of climatic zone maps, indicating optimum dates for first cut, critical fall harvest periods, and hay-drying potential for each zone, were developed in cooperation with the Land Resource Research Institute, Ottawa. In addition, a soil map indicating suitable areas for forage production in the region was developed. This was achieved in cooperation with the New Brunswick Department of Agriculture.

Grass silage for young calves. Liveweight gains of up to 1 kg/day were observed in dairy-type calves of 8–12 wk of age that were fed grass silage free-choice plus concentrate at 2 kg/day. High-quality grass silage can partly replace concentrates in the diet of young calves, thus potentially reducing feed costs.

Quality of fall-harvested red clover silage. Red clover silage digestibility was estimated to decrease by 0.3% for each day of delay in the fall harvest. Fall growth of red clover was evaluated as direct-cut silage and as wilted silage in sheep feeding trials. Dry-matter content was 13% on the direct-cut silage and 22% on the silage wilted for 4 h prepared on 5 August, and 22% on the direct-cut silage and 50% on the silage wilted for 16 h, prepared on 25 August. Intake of dry matter was higher for the wilted silage than for the direct-cut silage (3.2% versus 2.8% body weight) prepared from either of the fall harvests. The silage that was cut ealier was more digestible than the silage that was cut later (73% versus 57%).

Sulfur nutrition of forages. Alfalfa and timothy did not respond to S applications. Sulfur concentrations in the tissue as low as 0.14–0.18 μg/g were adequate, but are close to levels found to be deficient in other areas. It was concluded that S levels of tissue in the Atlantic region of Canada should be monitored at least every other year.

Effect of seed treatment with selenium. Selenium (Se) at 50–200 g/ha, applied to the seed maintained Se levels in the tissue greater than 0.1 μg/g (the level considered sufficient from the viewpoint of livestock nutrition) in three cuts of alfalfa and Westerwolds ryegrass.

Effects of chemical and mechanical conditioning on the field drying of red clover. The combined application of desiccant spray and mechanical conditioning could reduce haying time by up to 24 h. Red clover in half bloom stage was sprayed with a desiccant solution at the time of cutting in early August. Freshly cut material contained 19% dry matter. After 20 h of field drying, the dry-matter content was 39% in the control, 47% in the desiccant-sprayed herbage, 44% in the flail-conditioned material, and 53% in the desiccant-treated, flail-conditioned crop.

Performance of sod-seeded temperate legumes in grass-dominant swards. Sod-seeded red and white clovers were the best established and the most productive species in small plot experiments and field scale trials conducted to determine the establishment and growth of sod-seeded alfalfa, red clover, white clover, and birdsfoot trefoil as both pasture and hayland in fine sandy loam soils in Prince Edward Island.

It was estimated that in the postseeding year, sod-seeding of clovers resulted in yields comparable to those of stands fertilized annually with N at 100–150 kg/ha. Birdsfoot trefoil and alfalfa had variable establishment and usually made a limited contribution to sward productivity. Timothy sod-seeded in conjunction with red clover, white clover, or alfalfa was established satisfactorily with all three legume species used.

Effect of spacing and summer applications of ammonium nitrate on orchardgrass. Orchardgrass was grown for 5 yr on a fine sandy loam fertilized with N as ammonium nitrate at 40–120 kg/ha applied in either spring or summer, or in combination. Stands were cut two or three times during each growing season. Single N applications in spring increased annual yield by about 11% over equivalent summer applications. For split applications, no significant difference in annual yield was found, regardless of whether the greater fraction was applied in spring or summer. Applications of N at 120–165 kg/ha were required to maintain uniform yearly production. The N concentrations in cut one and two were determined by the rate of N applied in spring and summer, but there was a carry-over effect from the first to the second cut for the highest rate of applied N in the 4th and 5th yr.

Insects and diseases

Evaluation of plant parasitic nematodes in forage legumes and grasses. Red clover, birdsfoot trefoil, alfalfa, and timothy were better hosts for *Pratylenchus* spp. than were Italian and Westerwolds annual ryegrasses, perennial ryegrass, orchardgrass, and bromegrass. Numbers of *P. penetrans* (Cobb, 1917) were very low, whereas numbers of *Tylenchorhynchus* spp. and *Pratylenchus* spp. were high in five cultivars of Italian and Westerwolds ryegrass.

Insect control of tansy ragwort. European flea beetles, *Longitarsus jacobaeae* (Waterhouse), were released in a field infested with tansy ragwort near Charlottetown in 1981. They have survived two winters and are established. The larvae feed on the ragwort root crowns in fall and spring, and should supplement the foliage-feeding cinnabar moth *Tyria jacobaeae* (L.) in an attempt to reduce tansy ragwort with insects in Prince Edward Island.

HORTICULTURAL CROPS AND TOBACCO

Vegetables and tobacco

Effects of N, P, K, and B on strawberry yields. A postplanting application of N at 180 kg/ha increased first-crop strawberry yields by 30%, and an additional application of N at 180 kg/ha applied immediately following harvest of the first crop increased second crop yields by 70%. Similar applications of P at 197 kg/ha increased first- and second-crop yields by 30% and 45%, respectively. Yields were not affected by added K or B.

Cabbage cultivars with improved storage ability. Field experiments have shown that Houston Evergreen may be replaced by cultivars that have better keeping qualities. The best of 16 cultivars evaluated during three consecutive seasons were Ladena and Bartolo. Other cultivars that also produced heads of about the same size and were rated as having better keeping qualities than Houston Evergreen were April Green, Decema Extra, Ladena, Storage Green, and Evergreen Ballhead.

Weed control in native lowbush blueberries. Trials indicate that hexazinone controls several weed species. A single application at the rate of 1.5 kg/ha in early May, after burning and before growth starts, resulted in a mean increase in yield of 50% in the following fruiting year. Yields were increased by 30% where ammonium nitrate was applied at 150 kg/ha 2 wk after the hexazinone application.

Boron deficiency and toxicity symptoms in some vegetables. Symptoms of B deficiency showed as yellowing of tops with slow flowering in beans; as brown cut root with thick periderm in radishes; and as reduced growth in tomatoes. Boron toxicity showed as marginal burning and dark brown tips of older leaves in beans and tomatoes. No toxicity was found in radishes at B levels in soil of up to 4 μg/g.

Soil pesticides. In many fields that have been treated for 2 yr or longer with the carbamate insecticide carbofuran, strains of microorganisms have developed to rapidly break down the insecticide. Subsurface treatments that formerly persisted to provide good residual control of soil insects for 3–4 mo are now degraded in 2–3 wk. The degrading strains have not been found in fields with soil pH of 5.8 or lower. However, once developed in higher pH soils, the microbes can function and break down carbofuran even when the pH is lowered to about 5.1. Strains of microorganisms capable of breaking down the organophosphorus compound fensulfothion have also developed.

Slug control. Spray applications of nematicidal chemicals such as the organophosphorus compounds nemacur and fensulfothion and the carbamate materials oxamyl, aldicarb, methomyl, and methiocarb (all of which contain a methylthio moiety), as well as the carbamates aminocarb and mexacarbate (containing a dimethylamine moiety in place of methylthio) were effective in destroying infestations of the gray garden slug. However, sprays gave good results only when applied as a contact treatment and were most effective when applications were made during relatively dry weather and after 10:00 p.m. or 11:00 p.m., when slugs were actively feeding on plant foliage.

Potato management and pest control

Washing of tubers. Mature females and cysts of the clover-cyst nematode, *Heterodera trifolii* (Goffart 1944), were not detected on tubers that had passed through a commercial wash. Washing did not encourage storage rot under recommended storage conditions.

Late blight prevention. Metalaxyl provided some control early in the season but resulted in more disease by the end of the growing season than did the use of two contact fungicides, mancozeb and chlorothalonil.

The use of a controlled-droplet sprayer for application of fungicides for late blight control was inferior to a conventional sprayer.

Nitrogen requirement of Shepody potatoes. The greatest yield of Shepody tubers over 52 mm occurred where N was applied at 100 kg/ha and plants were topkilled 90 days after planting. When plants were topkilled 105 days after planting, N at 150 kg/ha was required for maximum yield of tubers greater than 52 mm. As N was increased from 0 to 250 kg/ha, the specific gravity of the tubers dropped from 1.076 to 1.066 at 90 days and from 1.087 to 1.075 at 105 days after planting.

Nitrogen requirement for Kennebec seed production. A maximum total yield of Kennebec tubers of 33.8 t/ha occurred when N was applied at 100 kg/ha and plants were topkilled after 88 days; N at 168 kg/ha gave a maximum yield of 43.7 t/ha when plants were topkilled after 102 days. Only 30% of the early yield was under 50 mm, and 83% was under 75 mm. At the time of the late harvest, 17% of the tubers were under 50 mm and 61% under 75 mm.

Bintje spacing for table stock production. In-row spacings of 35, 43, and 52 cm produced total Bintje yields of 43.9, 42.8, and 41.2 t/ha, respectively, with 67, 72, and 73% of the tubers over 52 mm in diameter. Planting small whole seed produced 43.0 t/ha; planting large whole seed produced 43.6 t/ha; and large seed cut in half produced 41.4 t/ha, with 77, 63, and 72% of the respective tubers exceeding 52 mm in diameter.

Greensprouting of Bintje seed. Bintje seed greensprouted in light for 6 wk and plants topkilled 80 days after planting produced 37.4 t/ha, with only 1.8 t exceeding 50 mm in diameter. Non-greensprouted seed produced only 31.0 t/ha, with 0.9 t/ha exceeding 50 mm. Topkilling 12 days later increased yields to 47.7 and 40.0 t/ha, with 6.7 and 4.0 t/ha exceeding 60 mm for the greensprouted and non-greensprouted seed, respectively.

Plant spacing and topkill dates for Bintje seed production. Three in-row plant spacings (25, 18, and 10 cm) combined with two topkill dates produced Bintje seed size yields (under 50 mm) averaging 33.6, 32.6, and 27.0 t/ha, with decreasing spacing and early topkill, and 41.8, 35.0, and 31.9 t/ha 2 wk later. The average total yields for the respective treatments were 29.9, 34.2, and 34.8 t/ha for the early topkill and 41.4, 42.2, and 45.4 t/ha for the later topkill.

Chemical top-desiccation of seed potatoes. Total tuber yields of three cultivars, Kennebec, Sebago, and Bintje, harvested 2 wk after the application of desiccant averaged 2.0, 3.0, and 3.2 t/ha higher, respectively, than the green yields obtained at the time of desiccant application over a series of harvest dates. The yield of seed-size Kennebec tubers (35–65 mm) did not change significantly among the 2-wk periods after desiccation. Bintje seed size yields increased after application of desiccant. The yields of seed size Sebagoes were affected by both desiccation and date of desiccation.

Viruses associated with mosaic in Russet Burbank potatoes. An ELISA survey of Russet Burbank potato fields in Prince Edward Island in 1983 for potato viruses X (PVX), A (PVA), and Y (PVY) indicated that 66% of the mosaic samples were positive for PVX only, 27% were positive for PVA and PVX, and 4% were positive for PVA only. Potato virus Y was detected, alone or in combination, in only 3% of the samples. On the basis of symptom severity, infection with PVX alone was associated with 82% of the plants with mild mosaic symptoms and 27% of those with severe symptoms, whereas mixed infection of PVX and PVA was associated with 12% and 66% of these groups, respectively. Measures to control mosaic should be aimed at PVX, and greater consideration should be given to the importance of PVA because symptom-inducing and symptomless strains of PVX cannot be serologically distinguished. These results indicate that the use of ELISA cannot replace visual indexing in a system of seed inspection based upon visual tolerances.

PUBLICATIONS

Research

Carter, M. R. 1983. Growth and mineral composition of barley and wheat across sequences of Solonetzic soil. Plant Soil 74:229-235.

Carter, M. R.; Rennie, D. A. 1982. Changes in soil quality under zero tillage farming systems: Distribution of microbial biomass and mineralizable C and N potentials. Can. J. Soil Sci. 62:587-597.

Choo, T. M. 1983. Doubled haploids for locating polygenes. Can. J. Genet. Cytol. 5:425-429.

Cutcliffe, J. A.; Gupta, U. C. 1983. Effect of applied copper on vegetable crops grown in Prince Edward Island. Can. J. Soil Sci. 63:757-760.

Gupta, U. C. 1983. Boron deficiency and toxicity symptoms for several crops as related to tissue boron levels. J. Plant Nutr. 6:387-395.

Gupta, U. C.; Kunelius, H. T.; Winter, K. A. 1983. Effect of foliar-applied selenium on yields and selenium concentration of alfalfa and Westerwolds ryegrass. Can. J. Soil Sci. 63:455-459.

Gupta, U. C.; Winter, K. A.; Kunelius, H. T. 1983. Effect of treating seed with selenium on the selenium concentration of alfalfa and Westerwolds ryegrass. Can. J. Soil Sci. 63:641-643.

Ivany, J. A.; Enman, J. R. 1983. Herbicides for forage corn no-till seeded into cereal stubble. Can. J. Plant Sci. 63:235-241.

Ivany, J. A.; Sadler, J. M.; Kimball, E. R. 1983. Rate of metribuzin breakdown and residue effects on rotation crops. Can. J. Plant Sci. 63:481-487.

Jensen, K. I. N.; Ivany, J. A.; Kimball, E. R. 1983. Efficacy of three dinitroanaline herbicides in processing peas and their residues in soil. Can. J. Plant Sci. 63:687-693.

Kimpinski, J.; El Eraki, S. 1983. Influence of aldicarb, carbofuran, propoxur, and fenamiphos on activity of *Pratylenchus penetrans* (Cobb) and *P. crenatus* Loof. Rev. Nematol. 6:103-110.

Kimpinski, J.; Johnston, H. W.; Willis, C. B. 1982. *Pratylenchus crenatus, Tylenchorhynchus dubius* and *Bipolaris sorokiniana* in spring-seeded cereals and timothy. Can. J. Plant Pathol. 4:362-366.

Kunelius, H. T.; Narasimhalu, P. 1983. Yields and quality of Italian and Westerwolds ryegrasses, red clover, alfalfa, birdsfoot trefoil, and Persian clover grown in monocultures and ryegrass-legume mixtures. Can. J. Plant Sci. 63:437-442.

Major, D. J.; Bootsma, A.; Brown, D. M.; Dupuis, G.; Fairey, N. A.; Grant, E. A.; Green, D. G.; Hamilton, R. I.; Langille, J.; Sonmor, L. G.; Smeltzer, G. C.; White, R. P. 1982. An evaluation of the corn heat unit system for the short-season growing regions across Canada. Can. J. Plant Sci. 63:121-130.

Narasimhalu, P.; Choo, T. M. 1983. Effect of potassium carbonate on drying of red clover under humid field conditions. Z. Acker. Pflanzenb. 152:159-163.

Narasimhalu, P.; Winter, K. A.; Kunelius, H. T.; McRae, K. B. 1982. The effect of nutrient composition on the voluntary intake and apparent digestibility of first and second-cut grass hays prepared in Prince Edward Island. Can. J. Plant Sci. 62:935-939.

Nass, H. G. 1983. Effectiveness of several selection methods for grain yield in two F_2 populations of spring wheat. Can. J. Plant Sci. 63:61-66.

Nass, H. G. 1983. Relationship of plant water content and winterhardiness of winter wheat and fall rye grown in Atlantic Canada. Can. J. Plant Sci. 63:67-72.

Platt, H. W. 1983. Effects of metalaxyl, mancozeb and chlorathalonil on blight, yield and tuber rot of potato. Can. J. Plant Pathol. 5:38-42.

Platt, H. W.; Ivany, J. A. 1983. Potato late blight control and top desiccation when pesticides are applied with a controlled droplet and a conventional sprayer. Am. Pot. J. 60:939-947.

Read, D. C. 1983. Bioassay of toxicity of insecticides in soil using eggs and larvae of the cabbage maggot, *Hylemya brassicae* (Diptera: Anthomyiidae). Can. Entomol. 115:573-576.

Read, D. C. 1983. Enhanced microbial degradation of carbofuran and fensulfothion after repeated applications to acid mineral soil. Agric. Ecosystems Environ. 10:37-46.

Read, D. C.; Gaul, S. O. 1983. Movement and residual toxicity of carbofuran in acid mineral soil. Agric. Ecosystems Environ. 9:57-68.

Regab, M. T. H.; Abdel-Kadir, M. H. K.; Ivany, J. A. 1983. Residues of carbofuran and its two carbamate metabolites in field-treated rutabaga. J. Environ. Sci. Health Part B:301-304.

Stout, D. G.; Suzuki, M.; Brooke, B. 1983. Nonstructural carbohydrate and crude protein in pinegrass storage tissues. J. Range Manage. 36:440-443.

Sturz, A. V.; Johnston, H. W. 1983. Early colonization of the ears of wheat and barley by *Fusarium poae*. Can. J. Plant Pathol. 5:107-110.

White, R. P.; Sanderson, J. B. 1983. Effect of planting date, nitrogen rate, and plant spacing on potatoes grown for processing in Prince Edward Island. Am. Pot. J. 60:115-125.

Winter, K. A.; Gupta, U. C. 1983. The mineral content of timothy grown in Prince Edward Island. Can. J. Anim. Sci. 63:133-139.

Miscellaneous

Arsenault, W. J. 1983. P.E.I. tobacco grower used wood-burning unit to cure 1982 crop. Lighter 53(1):15.

Bootsma, A.; Suzuki, M. 1983. Critical fall rest period for alfalfa in the Atlantic region. Canadex 121.07.

Choo, T. M. 1983. Doubled haploids in quantitative genetics and plant breeding. Pages 91-97 *in* Yap, T. C.; Graham, K. M.; Sukaimi, J., eds. Crop improvement research. Proceedings of the 4th International SABRIO Congress. The Society for the Advancement of Breeding Researches in Asia and Oceania. Bangi, Selangor, Malaysia.

Choo, T. M.; Suzuki, M. 1983. Cold hardiness of red clover. Canadex 122.31.

Craig, D. L.; Cutcliffe, J. A.; MacRae, K. B. 1983. Effects of plant thinning and row width on yield and mean fruit weight of three strawberry cultivars. Adv. Strawberry Prod. 2:1-6.

Cutcliffe, J. A. 1983. Effect of limestone and potassium on yields of cabbage. Canadex 543.252.

Cutcliffe, J. A.; Gupta, U. C. 1983. Effect of applied copper on vegetables grown in Prince Edward Island. Canadex 250.23.

Cutcliffe, J. A.; Gupta, U. C. 1983. Residual effect of boron on barley and wheat. Canadex 533.10.

Cutcliffe, J. A.; Sanderson, K. R. 1983. Black currant cultivar trial, Prince Edward Island. Canadex 238.34.

Cutcliffe, J. A.; Stevenson, R. C. 1983. Trials of cabbage cultivars for yield and storage ability. Canadex 252.65.

Gupta, U. C. 1983. Boron requirement of forage legumes. Canadex 120.532.

Ivany, J. A.; Enman, J. R. 1983. Herbicides for no-till forage corn. Canadex 641.111.

Kimpinski, J.; Platt, H. W. 1983. Washing of potatoes to remove nematodes and to observe effect on storage rot diseases. Can. Plant Dis. Surv. 63:45-46.

McDonald, J. G.; Suzuki, M. 1983. Occurrence of alfalfa mosaic virus in Prince Edward Island. Can. Plant Dis. Surv. 63:47-50.

Platt, H. W.; White, R. P. 1983. Growing Russet Burbanks for processing potatoes in Canada. Agribook Magazine, Vol. 9, No. 4.

Read, D. C.; Gaul, S. O. 1983. Adaptive microorganisms can develop to rapidly break down insecticides in re-treated soil. Can. Agric. 29:28-30.

White, F. H.; Pandeya, R. S.; Arsenault, W. J. 1983. Windel high yielding, wind tolerant, flue-cured tobacco for the Maritimes. Lighter 53(1):31-33.

White, R. P.; Sanderson, J. B. 1983. Evaluation of Symbex and Symbooster Plus using potatoes and ryegrass. Canadex 100.23.

Research Station
Kentville, Nova Scotia

PROFESSIONAL STAFF

Administration

G. M. Weaver, B.Sc., Ph.D.	Director
R. G. Ross, D.F.C., B.Sc. (Agr.), M.Sc., Ph.D.	Assistant Director
G. P. Shortt	Administrative Officer

Scientific Support

K. B. McRae, B.Ed., M.S., Ph.D.	Regional Statistician
J. R. Miner,[1] B.A., M.L.S.	Librarian
W. D. Regan,[2] B.Math.	Computer Systems Manager
H. Myer, B.Sc.	Computer Systems Programmer

Agronomy

R. W. Jones, B.Sc., M.Sc., Ph.D.	Head of Section; Cereal physiology and management

Berry Crops

I. V. Hall, B.Sc., M.Sc., Ph.D.	Head of Section; Berry crops ecology and management
C. R. Blatt, B.Sc., M.Sc., Ph.D.	Crop physiology and nutrition
A. R. Jamieson,[3] B.Sc., M.Sc.	Berry crops breeder
N. L. Nickerson, B.Sc., M.Sc.	Berry crops diseases

Crop Protection

R. G. Ross, D.F.C., B.Sc., (Agr.), M.Sc., Ph.D.	Head of Section; Tree fruit diseases
M. G. Anderson, B.Sc., Ph.D.	Vegetable storage and cereal diseases
S. O. Gaul,[4] B.Sc., M.Sc.	Residue chemistry
J. M. Hardman, B.Sc., M.Sc., D.I.C., Ph.D.	Insect ecology
P. D. Hildebrand,[5] B.Sc., Ph.D.	Berry crops and vegetable diseases
K. I. N. Jensen, B.Sc., M.Sc., Ph.D.	Weed physiology
E. R. Kimball, B.Sc.	Residue chemistry
C. L. Lockhart, B.Sc. (Agr.), M.Sc.	Berry crops and vegetable diseases
W. T. A. Neilson, B.Sc., M.Sc.	Fruit maggots
M. T. H. Ragab, B.Sc., M.Sc., Ph.D.	Residue chemistry
K. H. Sanford, B.Sc. (Agr.), M.Sc.	Integrated control on orchard pests
H. B. Specht, B.Sc. (Agr.), M.Sc., Ph.D.	Field crops and vegetable insects

Ornamentals

P. R. Hicklenton, B.Sc., M.Sc., Ph.D.	Head of Section; Ornamental and greenhouse crops physiology

Poultry

F. G. Proudfoot, B.Sc. (Agr.), M.S.	Head of Section; Poultry physiology and management
H. W. Hulan, B.Sc. (Agr.), M.Sc., Ph.D.	Poultry nutrition and physiology

Processing and Storage

R. Stark, B.Sc., Ph.D.	Head of Section; Food technology
J. M. Burrows, B.Sc. (Ag. Eng.)	Food engineering
E. D. Jackson, B. Tech., M.Sc., Ph.D.	Food microbiology
R. A. Lawrence, B.Sc. (Chem. Eng.), M.Sc. (Food Eng.)	Food engineering
P. D. Lidster, B.Sc., M.Sc., Ph.D.	Storage physiology
P. A. Poapst, B.Sc. (Agr.)	Storage physiology

Tree Fruits

A. D. Crowe, B.Sc. (Agr.), M.Sc., Ph.D.	Head of Section; Tree fruit breeding and physiology
C. G. Embree, B.Sc. (Agr.)	Tree fruit physiology and management
D. H. Webster, B.Sc., M.Sc., Ph.D.	Soils and nutrition

Vegetables

C. L. Ricketson, B.Sc. (Agr.), M.S., Ph.D.	Head of Section; Vegetable physiology and management

Departures

D. L. Craig, B.Sc. (Agr.), M.Sc., Ph.D. Retired 26 August 1983	Berry crops breeding
H. J. Herbert, B.Sc. (Agr.) Retired 9 September 1983	Pheromones and mites
W. G. Simpson, B.S.A., M.S. Deceased 17 November 1983	Food technology

Experimental Farm, Nappan, N.S.

F. W. Calder, B.Sc. (Agr.), M.S.	Officer in Charge; Forage crops and agronomy
J. E. Langille, B.Sc. (Agr.)	Agronomy, cereal and forage crops
T. A. Van Lunen, B.Sc. (Agr.)	Swine management and nutrition

---

[1] Seconded from Libraries Division, Finance and Administration Branch.

[2] Seconded from Systems and Consulting Directorate, Finance and Administration Branch.

[3] Appointed 10 May 1983; On educational leave to University of Guelph, Guelph, Ont., from 10 May 1983.

[4] On educational leave to University of Guelph, Guelph, Ont., from 2 September 1983.

[5] Appointed 6 September 1983.

INTRODUCTION

This report highlights the principal research currently under conduct at the Kentville Research Station and the Nappan Experimental Farm for 1983. Both establishments are located in Nova Scotia, where Kentville serves as the Atlantic regional center for research on poultry, horticultural crops, and winter cereals, as well as the storage and processing of food crops. Research at Nappan is concentrated on the management of beef, sheep, and swine, and on their related feed crops requirements.

The region itself is characterized by a cool, humid climate. Soils are generally low in fertility and often imperfectly drained. The diverse agriculture that it sustains is predominantly a livestock base but has major concentrations of fruit and vegetable production in locally adapted areas.

The Station was shocked at the sudden passing of William G. Simpson, food technologist, on 17 November 1983. Mr. Simpson joined the staff on 17 June 1968 and played a major role in developing the food technology program. He played an active part in the community, especially the church and the Boy Scout movement.

Requests for further information or reprints of publications should be addressed to the Research Station, Research Branch, Agriculture Canada, Kentville, N.S. B4N 1J5.

G. M. Weaver
Director

BREEDING, NUTRITION, AND CULTURE OF CROPS

Lowbush blueberries

Genetic improvement. The mean berry weight from four progeny crosses of select clones of lowbush blueberry (*Vaccinium angustifolium* Ait.) was significantly greater than that of three progenies from open-pollinated female parents, identified as select clones. Mean yields from both of these sources were significantly greater than from the three progenies from wild stands. The mean yield from both types of progenies involving select clones was also significantly greater than that from wild stands; however, the mean from the progenies with two select clones as parents was greater only at $P < 0.05$ than the mean of those progenies having only one known parent as a select clone.

Harvesting. A mechanical harvester developed for lowbush blueberries (*Vaccinium angustifolium* Ait.) was demonstrated in a field trial to be potentially viable for machine harvest. On a well-managed, relatively weed-free field, four experienced hand rakers were able to harvest a larger percentage of the fruit than was the machine, but it took about eight times as long to do so. The quality of the berries, as measured by percentage of poor berries and amount of foreign material, was not significantly different between hand- and machine-gathered berries. On a field that contained a considerable native weed population, the hand rakers were able to extract a greater harvest with better berry quality. The cost of hand picking 50 t of berries at 1982 prices was in the vicinity of $15 000. By contrast, the harvester could do the same job in suitable fields for $6000, based on a cost of $25 an hour for the machine and operator.

Plant spacing and cultivars. Augusta, Brunswick, Chignecto, and 510 were harvested for the second consecutive season. Yields in grams per plant continue to show marked differences among cultivars. Brunswick increased its yield (grams per plant) 120% from single- to double-row spacings, whereas yields from Augusta, Chignecto, and 510 increased only 15, 8, and 12% respectively. Double-row spacing produced the highest average (all cultivars combined) yields (grams per plant) and these were 17 and 9% higher than those from single- and triple-row spacings, respectively. Average yields of individual plants doubled for all but the Brunswick cultivar between 1982 and 1983, and mean yield per hectare over all clones was 4.1, 5.8, and 5.5 t for the single, double, and triple spacings, respectively.

Management and nitrogen fertilizer. Augusta, Chignecto, 206, and 74-2 have been fruited for the fifth time in a continuing experiment. Results indicate that double cropping prior to a sprout year increases yields an average of 29%, compared with only one crop prior to a sprout year. Nitrogen fertilization did not improve growth over that from nonfertilized plants.

Strawberries

Management study with the cultivar Bounty. Trickle irrigation significantly increased marketable yields at each harvest, total marketable yields, and total season yield. It also increased either marketable or total fruit size, or both, at each harvest and for the total season.

Plant thinning and row width on yield and fruit size. Three crops from the strawberry cultivars Bounty, Micmac, and Redcoat were grown at two locations, with both thinned and unthinned matted rows in three different row widths—30, 45, and 60 cm. The response at Kentville depended upon the cultivar; thinning increased marketable yield from Micmac, but not in rows 45 cm wide, and from Bounty, especially in rows 30 cm wide. Thinning also increased the fruit size of both cultivars. Plant thinning and width of row had no significant effect on yield of marketable fruit and fruit size at Charlottetown, P.E.I. These results indicate that the current general recommendation in Atlantic Canada to grow strawberries in rows 45–60 cm wide is acceptable for unthinned rows. If commercial growers wish to adopt thinning as a standard cultural practice, then cultivars should be evaluated in narrow rows.

Apples

Response of apple growth and flowering to shade and ground covers. Summerland (regular-bearing) and Macspur (spur-bearing) apple trees (*Malus domestica* Borkh.) on Malling (M) 26 rootstock were grown in pots under four shade treatments (100, 88, 50, and 12% full sun) and with grass, bare soil, and white plastic ground covers. Macspur trees grew and flowered more than Summerland trees. The two strains responded similarly to shade, but differently to ground covers. The greatest increase in fresh weight, number of shoots, and blossom clusters for Macspur resulted with white plastic, whereas the least response was with grass; the reverse held for Summerland.

Relationships between Mg, K, and Ca of apple fruit. The Mg concentration of whole apple fruit samples (fewer seeds and less stem) on a fresh-weight basis is frequently a significant function of both K and Ca concentration. Mg concentration calculated from the regression

$$\text{ppm Mg} = 15.95 + 0.0204 \text{ ppm K} + 0.226 \text{ ppm Ca}$$

was usually close to observed Mg. The observed positive coefficient for Ca of about 0.2 is consistent with a movement of Mg with Ca into apples via xylem in a ratio of about 1:5, a common ratio in xylem sap.

Cereals

Effect of spring nitrogen on vegetative and grain performance of Lennox winter wheat. A lodging-prone cultivar such as Lennox, if it makes very good growth in the fall and survives the winter well, is better off without early N if it is not protected with growth regulator and fungicide in an integrated management approach. Other experiments showed that the provision of such integrated management on this cultivar furnished highly remunerative yield increases of up to 1.2 t/ha.

Multifactorial effects of growth regulators and fungicides on performance of Lennox and Monopol winter wheats. In multifactorial experiments on Lennox and Monopol winter wheats, all management input in concert (i.e. the early and late growth regulators chlormequat and ethephon, respectively, and the broad-spectrum fungicide propiconazole applied early and late) maximized the yield of Lennox 28% above the basic N-only management to 5.42 t/ha. In Monopol, the maximum yield of 5.10 t/ha was 23% above the basic and was achieved with selective management options of chlormequat and early propiconazole only; full management produced almost 0.5 t less than the maximum. Chlormequat and ethephon independently reduced lodging of both cultivars and respectively shortened the lower and upper plant internodes. Acting together, the two regulators additively reduced lodging still further and shortened internodes along the entire length of stem. Ethephon treatment stimulated a dramatic increase in ear *Septoria* in both cultivars, an effect which was diminished by the earlier chlormequat application in Monopol and suppressed entirely by the combined fungicide applications in both cultivars. Early propiconazole in Lennox and late propiconazole in Monopol also appeared to be stressful, but combined early plus late fungicides were very effective in suppressing ear-borne diseases. Fungicide treatment produced highly significant statistical effects on yields in both cultivars, whereas growth regulatory effects were significant in Monopol only. It is concluded that interaction, both among the various types of input of integrated management and with specific features of crop development, can negatively or positively influence crop development and performance and that cultivar-specific needs can dictate a selection of management options for maximum effect.

Effectiveness of a single, mixed fungicide application on winter wheat. The mixture of propiconazole–chlorothalonil fungicides was more effective than either fungicide alone in controlling late-season diseases on cereals. Applied at the late boot stage (prior to any lodging) as a tank mix containing propiconazole at the rate of 300 mL/ha and chlorothalonil at 1 L/ha, the mixture proved to be very effective, increasing the yield of Lennox by 24%, to 4.38 t/ha, and Monopol by 40%, to 4.07 t/ha. Associated with yield increases were very significant disease-controlling effects on mildew and *Septoria*.

Interaction of seeding dates, seeding rates, and interrow widths in the performance of winter wheat. Strong interactions of seeding date with seeding rates and interrow widths occurred and produced consistent similar trends for both Lennox and Monopol winter wheats. For 15 September seeding with 10-cm rows, the yield with 350 kernels per square metre averaged 10% higher than with 500 kernels per square metre, but with 20-cm rows the corresponding yield was 4% lower. In contrast, for 5 October seeding with 10-cm rows, yields were 27% higher with 500 than with 350 kernels per square metre, whereas with 20-cm rows the rate of 350 kernels per square metre was 8% more effective. An intermediate seeding date (25 September) produced changes between these two extremes, indicating the progressive movement from one set of interactions to another with seeding delay. These different interactions within and between seeding dates correlated with parallel changes in ear *Septoria*, but not ear mildew levels, in such a way that *Septoria* level was inversely related to yield averaged over both cultivars for a given date of seeding.

Requirement for snow cover for winter wheat. Yields of Monopol and Lennox winter wheats were not affected by removing snow cover during the winter of 1982–1983. Monopol is less winter-hardy than Lennox under maritime conditions, and therefore this experiment confirms that the winter of 1982–1983 was benign and without major influences on subsequent productivity. A similar experiment in 1982 indicated that snow cover was not important to sustain Lennox yields at the Kentville Research Station.

Duration of winter related to grain productivity. Winters in the Maritimes differ from those in Europe in that they are longer and more severe. It is not known whether the length of winter per se, i.e., the duration of the inert growing phase of a winter cereal, has implications for its grain productivity. To approach this question, plants of Lennox in the winter of 1981–1982 and Monopol and Lennox in the winter of 1982–1983 were dug from the field, repotted, and raised in growth chambers that simulated average spring and summer growing conditions in the Annapolis Valley. Total grain yields per plant increased for field residence in January (Lennox 38% in 1982, Lennox 20% and Monopol 8% in 1983), indicating the completion of vernalization requirements. Thereafter yields steadily declined towards the end of March, with Lennox losing 76% in 1982 and 60% in 1983 and Monopol losing 46% in 1983. It would therefore seem that potential for productivity is lost locally during the inert winter phases. This may be one reason why European cultivars fail to achieve European yields when grown in the Maritimes.

Ornamentals

Hydroponic production of cut chrysanthemums. The cut chrysanthemum Polaris has been grown in a hydroponic system that has utilized vinyl eavestroughing 10.8 m long on a 1.5% slope. Nutrients were supplied by a complete commercial hydroponic fertilizer (18-9-27) supplemented with calcium and potassium nitrates, iron chelate, and nitric and phosphoric acids. The nutrient solution is circulated through the troughs. Cuttings were rooted in plastic cubes placed in a mist bed and then transferred to the troughs. Glasshouse temperatures were 21°C during the day and 15°C at night. All crops were divided between two benches, with six troughs supporting approximately 420 plants per bench. The fall crop had one bench supplied with a heated solution at 30°C (± 3°C) and no heat supplied to the solution in the other bench 16°C(± 2°C). Commercially acceptable spring, summer, and fall crops were produced by this production system. It is apparent that a heated solution is necessary in a fall crop to ensure adequate fresh weight, stem length, and uniformity.

Supplemental lighting of pot chrysanthemums during rooting, long-day, and short-day production stages. Studies have indicated improved quality and earliness of pot chrysanthemums following supplemental lighting (SL) with high pressure sodium (HPS) lamps during production. The effects of HPS lighting during rooting, long-day (LD), and short-day (SD) production stages, either singly or in all combinations, were investigated using the cultivar Paragon. Plants that were rooted under HPS lamps (approximately 250 μmol m^{-2} s^{-1}) flowered an average of 3 days earlier than those grown in daylight. During rooting, SL also decreased the number of days to full flower by an average of 2 days. Total plant dry weight and the number of flowering stem breaks per pot were increased by SL during all three stages. In general, the effects of SL on harvest parameters were additive, with lighting during each production stage offering the greatest benefit. The most significant economic benefits, however, will accrue from lighting during rooting and LD when fewer HPS lamps are required to light an equivalent number of plants, and continuous, 24-h lamp operation is possible.

Capillary bed irrigation of containerized woody ornamentals. A capillary bed system for the automatic irrigation of containerized woody ornamentals was devised and has been used successfully through two growing seasons. An inexpensive bridge-type temperature controller, in combination with stainless steel mesh sensors, is used to automatically control water flow on to a sand bed. Sensors are embedded horizontally and are separated by approximately 4 cm of sand. Current flow (conductivity) between the two sensors decreases as the sand dries, creating an imbalance in the bridge circuit. A solenoid valve is opened in response to output from the controller, and water flows on to the bed through a twin-wall seephose. Andorra and Prince of Wales juniper showed similar growth potential on the capillary bed or under overhead sprinkler irrigation. Plants grown in a medium consisting of two parts sand, one part peat, and three parts softwood bark showed reduced growth under both systems, as compared with a 1:1:3 medium.

Vegetables

Complete fertilizer versus dried fish silage. Broadcast treatments of 17-17-17 and two types of dried fish silage were applied at an N rate of 150 kg/ha prior to planting transplants of broccoli, cabbage, and cauliflower. Fish silage treatments supported yields of cabbage and cauliflower that were equal to or greater than those yields from the 17-17-17 treatment.

Effect of various plastic covers for row tunnels in advancing tomato maturity as influenced by type of soil mulch. The effectiveness of various types of plastic film as covers for individual row tunnels depended on the type of mulch applied to the soil surface (clear or black plastic, and unmulched). The tunnel covers used included the following: solid clear plastic; clear plastic with 0.5, 1.5, or 3.5% perforation (made with 1-cm holes); and three commercial films, Xiro, ASB, and one with vertical slits along each side. Tunnels with the Xiro, ASB, and 3.5% films, in combination with the clear plastic mulch, gave highest early yields: 9.9 t/ha of ripe fruit by mid August versus 5.5 t/ha for plots without tunnels but having the clear mulch. In this study, plants of the tomato cultivar Springset were set in the field on 30 May. Tunnels were opened only once or twice and were left open along one side most of the time, for ventilation.

Row tunnels covered with perforated plastic hasten tomato ripening. Individual-row tunnels covered with clear plastic film having 0.5, 1.5, or 3.5% perforation (made with 1-cm holes) were as effective as those covered with solid plastic in advancing maturity of the tomato cultivar Springset. All covered plants had similar early yields, and yield of ripe fruit to 8 August averaged 4.7 t/ha versus 0.4 t/ha for plants without tunnels. Tunnels with perforated covers required only one or two openings and closings during the season compared with nine for those covered with the solid film. Plants were set in the field on 20 May through a black plastic mulch. Tunnels were hand ventilated by lifting the plastic along one side when inside temperatures exceeded 35°C. To minimize opening and closing, tunnels were left open along one side over successive sunny days.

Preharvest defoliation of rutabaga with ammonium peroxydisulfate and ethephon. Ammonium peroxydisulfate applied to the point of runoff in aqueous concentrations of 1–2% was effective as a preharvest defoliant, promoting abscission in rutabaga. It also restrained root growth and so could provide some protection against the production of large-sized less marketable roots. Ammonium peroxydisulfate was compatible with ethephon supplied as Ethrel, and the two substances together provided a superior defoliating treatment.

Unsupported perforated plastic film for advancing maturity of broccoli. Unsupported (floating) plastic film advanced maturity of broccoli plants, transplanted to the field on 21 April, by a maximum of only 3–4 days. The types of film used included Xiro, ASB, and clear polyethylene with 0.5, 1.5, or 3.5% perforation (made with 1-cm holes). Cultivars responded somewhat differently to the films and films tended to be more effective in advancing maturity of the cultivars Bravo and Topstar than they were for Southern Comet and Green Hornet.

Use of multiple plants per transplant unit for broccoli. With the cultivar Premium Crop, the use of two or three plants per transplant unit resulted in yields that were 20–25% and 50–60% higher than those of single plants at plant-to-row spacings of 45 × 75 cm and 60 × 90 cm, respectively. At the 45 × 75 cm spacing, multiple plants gave yields equal to those of single plants at a spacing of 30 × 60 cm, with a saving of 50% in the number of units needed for transplanting. The use of multiple plants also offers advantages in raising transplants in that thinning of units is not needed and all units contain plants, leaving no wasted space.

A multivariate approach for the selection of cultivars with antagonistic traits. The process of evaluating cultivars was considered from the point of view of both the plant breeder and the crop evaluation committee. Although cultivar evaluation in plant breeding stresses continuing selection of superior material, whereas documentation of individual performance over general growing conditions is stressed in committee work, both are faced with the same difficulties when antagonistic traits are assessed simultaneously. A general unweighted multivariate procedure was developed, including adaptation to the particular emphasis. The proposed multivariate performance index was used to identify superior performance, in two and three traits simultaneously, of corn hybrids in an Atlantic regional trial.

PROTECTION OF CROPS AGAINST PESTS

Plant pathology

Apple replant disease control by soil fumigation. After 5 yr of growth in an orchard with diseased apple replants, the trunk cross-sections of Gravenstein and McIntosh apple trees in planting sites fumigated with Vorlex at doses of 112, 224, 336, and 448 L/ha were 19.3, 31.6, 35.1, and 34.3 cm^2, respectively, compared with 12.9 cm^2 in nonfumigated sites. After 2 yr of growth, there was no significant difference in tree growth between chloropicrin at 280 L/ha and the three higher rates of Vorlex; however, after 5 yr its effect decreased to that of Vorlex at 112 L/ha. The decline in efficacy was probably related to the relative size of the fumigated area rather than to any difference in fumigants. The higher growth rate of treated trees was considered to be only partly a result of initial reduction in the number of nematodes by the fumigants.

In another test, 3-yr-old Gravenstein and McIntosh affected by replant disease subsequently grew better left undisturbed than if lifted and replanted following site fumigation with chloropicrin.

Benomyl tolerance in apple scab. Tolerance of the apple scab fungus *Venturia inaequalis* (Cke.) Wint. for the fungicide benomyl was visibly evident for the first time in a commercial orchard in Nova Scotia in 1982. However, in a 1981 survey two of 19 isolates from one orchard and 10 of 17 isolates from another were tolerant of benomyl in culture. Benomyl tolerance was visibly evident in the latter orchard in 1983.

Evaluation of fungicides on apples Apple scab pressure was extremely severe, particularly in May, which had nine scab infection periods for a total of 292 h of wetness and 143 mm rain compared with a 50-yr average of 69 mm. Three infection periods occurred prior to the first spray, and because of infrequent good days for plot spraying, the interval between sprays was often excessive and their timing in relation to infection periods poor. Considering the extreme disease pressure, the experimental fungicides CGA-71818/captan (Ciba-Geigy), Ro 15-1297 (Maag), and DPXH 6573 (DuPont) gave outstanding scab control, whereas most fungicides such as the standard captan failed to hold scab. In this benomyl-tolerant orchard, the addition of carbendazim did not enhance the scab control obtained with mancozeb as the addition of benomyl appeared to do the previous year.

Control of twig and blossom blight of lowbush blueberries. Two applications of Funginex 1.9 E with active ingredient (a.i.) at 0.16, 0.21, 0.27, or 0.32 kg/ha followed by two applications of Ferbam with a.i. at 1.72 kg/ha effectively controlled twig and blossom blight (*Monilinia vaccinii-corymbosi* (Reade) Honey and *Botrytis cinerea* Pers.) of lowbush blueberries.

Detection of captan residues on apples, grapes, and strawberries. Residues of captan were extracted from fruit surfaces with salted water and detected on thin-layer chromatograms using resorcinol as a chromogenic reagent.

Gas chromatographic method for the analysis of propiconazole (Tilt) and etaconazole (Sonax) fungicides in winter wheat. Propiconazole (1-[2-(2,4-dichlorophenyl)-4-propyl-1, 3-dioxolan- 2 -yl-methyl [-1H-1,2,4,-triazole) and etaconazole (1-[2-(2,4-dichlorophenyl) -4-ethyl-1,3-dioxolan-2-yl-methyl]-lH-1,2,4-triazole) were extracted from chopped shoots and roots and ground straw and grains by shaking with methanol. After they were diluted with water, the compounds were isolated in dichloromethane, which was removed, and the residues were redissolved in hexane. Compounds were separated and analyzed by the electron capture gas chromatograph using a 3% OV-3 column at a temperature of 225°C. The procedure is simple and the limit of detection is 0.02–0.05 ppm.

Monitoring the blueberry maggot with Pherocon AM traps to determine spray requirements. Pherocon AM traps are very attractive to adults of the blueberry maggot, *Rhagoletis mendax* Curran, and are capable of detecting the adults before eggs are laid in the berries. Preliminary tests in 1983 have shown that these traps may be useful in monitoring adult populations to determine spray requirements because one spray of dimethoate applied 1 wk after the first capture provided excellent control of maggot. At present, two sprays are recommended the first, 1 wk after the appearance of the first ripe berry and a second, 7–10 days later.

Effects of hydroponic culture of chrysanthemums on survival of the leafminer of chrysanthemum. Hydroponic culture of chrysanthemums not only shows much promise as an alternative mode of production, but also prevents the buildup of populations of a serious greenhouse pest, the leafminer of chrysanthemum (*Liriomyza trifolii*). The vast majority of late instar larvae emerging from plants in an open-trough hydroponic system end up drowning in the nutrient solution, achieving a level of leafminer control seldom equaled by any registered insecticide currently available.

Efficacy of Trigard 75 WP (cryomazine) against Liriomyza trifolii *(Diptera: Agromyzidae).* The leafminer of chrysanthemum has attained the status of number one pest of the chrysanthemum greenhouse industry. The insect growth regulator Trigard was tested with a.i. at the following rates: 6.0, 4.5, 3.0, 1.5, and 0.3 g/L. All treatment levels gave significant ($\alpha = 0.05$) control compared with the unsprayed check. Phytotoxicity was observed on the cultivar White Marble and occurred at the four highest treatment rates. The a.i. rate of 0.3 g/L gave >80% control of leafminer larvae.

Pest abundance, pesticide use, and level of injury to fruit and foliage in orchards under a program of integrated pest management. Levels of abundance of insects and mites, quantities and types of pesticide used, and level of injury to fruit and foliage were monitored in apple orchards where a program of integrated pest management was in use. Apple yields increased from 1093 fruits per tree in 1980 to 1622 in 1982. Pest species that most frequently exceeded the economic threshold included the winter moth (82% of the orchard blocks), the European red mite (66%), the apple maggot (49%), stinging bugs (mainly the mullein bug and the apple brown bug)(40%), the eyespotted bud moth (38%) and the codling moth (28%). Over the 3-yr study, there were 2.46 insecticide treatments and 0.51 miticide treatments per block. Insecticide treatments cost $42/ha. The most expensive species to control were the winter moth ($17/ha), the apple maggot ($6.63/ha), the codling moth ($5.22/ha), and the tentiform leafminer ($5.07/ha). Miticide costs were $25/ha. Insect injury to fruit decreased from a mean of 3.6% of the apples harvested in 1980 to 1.8% in 1981 and 1.9% in 1982. The most damaging species were the codling moth (0.56% of the harvested apples), the rosy apple aphid (0.56%), fruit-chewing caterpillars, mainly the winter moth (0.54%), and stinging bugs (0.29%). Unacceptable levels of injury (1% of apples at harvest) were caused by rosy apple aphid (17% of the orchard blocks), codling moth (14%), fruit-chewing caterpillars (13%), and stinging bugs (7%). Less than 0.1% of the apples examined had egg punctures caused by the apple maggot, and surveys of apples for larvae in fruit indicated that over 99% of the orchard blocks were uninfested or had only a trace level of infestation. Damage to foliage was above the economic injury level in at least 33% of the orchard blocks. Species causing damage included the tentiform leafminer, the European red mite, the apple rust mite, and several defoliating *Lepidoptera*.

Residues of carbofuran and its two carbamate metabolites in field-treated rutabaga. Carbofuran was applied over the seeded rutabaga cultivar York, and residues of carbofuran, 3-hydroxycarbofuran, and 3-ketocarbofuran in the harvested roots averaged 0.15, 0.23, and 0.07 ppm in peel and 0.09, 0.14, and 0.05 ppm in pulp, respectively. Compounds were analyzed as their dinitrophenyl ether derivatives by the electron capture gas chromatography.

Herbicides

Analysis of potatoes treated with dinoseb and chlorbromuron herbicides. Preemergence applications of Sinox PE alone or in sequence with Sinox General and of Maloran in sequence with Sinox General to Netted Gem potatoes left no residues in tubers at harvest. Compounds were analyzed by the electron capture gas chromatography.

Atrazine carry-over detection in soil. A rapid and simple field procedure was developed where atrazine was reacted with pyridine and determined colorimetrically at 550 nm after the addition of alkali and ethyl cyanoacetate. The procedure is sensitive and much faster than bioassay methods for testing soils before cultivation with sensitive crops.

High performance liquid chromatographic determination of glyphosate and its major metabolite using precolumn fluorogenic derivatization. Glyphosate and aminomethylphosphonic acid were precolumn reacted with 9-fluorenylchloroformate then fluorometrically determined at 270–315 nm using high performance liquid chromatography. The technique is much faster than that of gas chromatography, sensitive, and successfully applied for residues in water, soil, and plant tissues.

Pronamide (Kerb) residues in field-sprayed lettuce. Neither preemergence or postemergence treatments of the lettuce cultivar Premium Great Lakes with prenamide containing a.i. at 1.75 kg/ha left residues in heads at harvest.

Residues of Dacthal and Kerb in 3-yr-old strawberry cultivars. Dacthal 75 WP with a.i. at the rate of 10 kg/ha and Kerb 50 WP with a.i. at the rate of 1.50 kg/ha were applied in June and November, respectively, to Bounty, Redcoat, Veestar, and Vibrant strawberry cultivars. Dacthal residues were below the tolerance limit in the same year. No Kerb residues were found in the berries the following year.

Residues of glyphosate and aminomethylphosphonic acid metabolite in soil and crops. Glyphosate disappeared rapidly in a sandy loam soil and degraded into aminomethylphosphonic acid, which also disappeared rapidly. Residues of glyphosate and metabolite were 0.0 and 6.2%, respectively, 122 days after the application of Roundup ® with a.i. at 4.25 kg/ha in the spring. Neither glyphosate nor its metabolite residues were found in field-grown barley, oats, wheat, sweet corn, beans, peas, red beets, or carrots. No injury symptoms were observed on any of the crops during the growing season. Compounds were analyzed as their methyl trifluoroacetate derivatives by the flame photometric gas chromatography.

ANIMAL SCIENCE

Pigs

Effect of rearing weaner pigs at three stocking densities on raised decks or solid flooring. Ninety-six weaner pigs were reared at densities of 0.37, 0.18, and 0.12 m^2 per pig on decks or in floor pens. At 25 kg, all were moved to floor pens at 1.44 m^2 per pig. A significant difference of stocking density occurred on rate of gain, days to market, and back fat.

Poultry

Effect of feed denial in starter diets on the performance of broiler chickens. A total of 2000 commercial broiler chickens were used in an exploratory experiment designed to estimate the effect of two daily feed denial treatments (8 and 12 h) extended from either 8–21 days or 15–28 days of age. Mortality was unaffected by these treatments. Body weight at 28 days was reduced, and feed conversion was improved by the feed denial treatments. The length of the daily feed denial period showed a greater impact than age of imposition, and the 12-h daily denial time diminished the growth performance. At 49 days, body weight and monetary returns were higher for the chickens exposed to the 8-h daily feed denial treatment extending from 8–21 days compared with the control group ($P < 0.10$).

Effects of dietary aspirin (acetylsalicylic acid) on the incidence of sudden death syndrome and the general performance of broiler chickens. A total of 2400 broiler chickens were used in four experiments to estimate the effects of using 0.04, 0.08, and 0.16% aspirin (ASA) as dietary supplements. Not only did the ASA dietary supplementation have no significant ($P > 0.05$) beneficial effect on the incidence of sudden death syndrome but it also had a deleterious effect on overall mortality, which was significant ($P < 0.01$) in two of the four experiments. Furthermore, the addition of ASA at 0.16% of the diet resulted in reduced body weights that were significant at $P < 0.05$ in two experiments and at $P < 0.10$ in the other two experiments.

Effect of feeding poultry diets supplemented with rapeseed meal as a primary protein source to juvenile and adult meat breeder genotypes. A factorial experiment was conducted, with a total of 3168 birds from four commercial meat parent genotypes, to study the cumulative effects of feeding soybean meal (SM) and rapeseed meal (RSM) as protein sources in both juvenile and adult breeder diets. Averaged over all genotypes, general performance was equivalent for all combinations of SM and RSM in the juvenile and adult diets, although there was some evidence of second-order interactions involving genotypes with juvenile and adult dietary combinations. These interactions affected egg production and related traits such as feed efficiency. It was concluded that some genotypes exhibit a greater responsiveness to rapeseed meal diets than others and that juvenile and adult diets using a combination of different sources of dietary protein supported equal or better performance compared with the same dietary protein source used throughout both periods.

Growth, heart weight, cardiac lipid, and pathology of chickens fed soybean oil or oil extracted from various rapeseed cultivars. A total of 384 male Single Comb White Leghorn chicks of the Hyline strain were placed at random in 24 Petersime battery units of 16 birds per unit. Four replicate pens were fed either a basal (control) diet containing no added oil or a diet supplemented with 20% by weight of either soybean oil or rapeseed oil (RSO) from the cultivars Tower, Candle, Regular, or R-500. Levels of erucic acid (22:1) in the RSOs ranged from 0.1 to 51.6%. Four birds from each unit were killed at 4, 8, 12, and 16 weeks for cardiac lipid analysis and pathology. Feeding RSO had no consistent effect on body weight, heart weight, or the heart-to-body-weight ratio. Only the diet containing R-500 (51.6%, 22:1) consistently increased cardiac lipid levels as measured gravimetrically. Maximum deposition of the long-chain monoenes (22:1) and eicosenoic acids (20:1) occurred in the cardiac lipids by 8 wk, and the levels remained high throughout the 16-wk trial. The relative concentration of these long-chain monoenes in the cardiac lipids was positively correlated to the dietary levels of these acids. The incidence of lesions found in heart, liver, and skeletal muscle was significantly higher in chickens fed RSOs high in 22:1 than in chickens fed control or soybean oil, and the incidence significantly correlated to the level of 22:1 in the diet. The incidence of heart and muscle lesions and hepatic necrosis in chickens fed RSOs low in 22:1 was not significantly different from that of chickens fed the control diet or soybean oil, but the incidence of sinusoidal distension was higher for chickens fed RSOs compared with those fed the control diet or the diet containing soybean oil.

Potato waste meal. I: Compositional analyses. Potato waste meal (PW), produced by drying and grinding whole potatoes, potato pulp and peelings, and off-color french fries and potato chips, contained slightly less crude protein (76 g/kg) but more lipid (70 g/kg), crude fiber (40 g/kg), and ash (40 g/kg) compared with corn. Although PW is not devoid of any of the essential or nonessential amino acids, it contained considerably less of each amino acid than corn did and appears limiting with respect to methionine and cystine, arginine, and the aromatic acids. The results suggest that this potato by-product might be considered a substitute ingredient for a proportion of the ground corn in practical diets for poultry and other livestock. Both PW and corn contain 4-hydroxyproline at levels of up to 0.46 and 0.34 g/kg, respectively. This discovery indicates that an amino acid previously thought to be confined almost exclusively to the collagens and elastins of vertebrates and invertebrates is not so confined. Thus, this hydroxyamino acid should no longer be used as an accurate index for assessing connective tissue content or the quality of composite protein supplements containing bone, meat, or fish meal.

Potato waste meal. II: The nutritive value and quality for broiler chickens. Two experiments were carried out to ascertain the nutritional value of potato waste meal (PW) as a replacement for corn in practical poultry diets using 320 male and 320 female Cobb chicks fed from 1 to 46 days old (experiment 1) and 49 days old (experiment 2) a basal cereal-based diet containing soybean and fish meal or test diets each containing PW at 50, 100, 150, 200, and 300 g/kg. In both experiments, the diets were analyzed for elemental and amino acid composition, and the growth responses on the test diets were evaluated individually over a period of 28 days and 46 days, or 49 days of ad libitum feeding. Although PW appeared limiting with respect to methionine and cystine, arginine, and the aromatic amino acids, it was found that upon supplementation with methionine (0.5 g/kg), the test mixtures exhibited a synergistic effect compared with controls, and that this potato by-product can be considered a good substitute ingredient for a proportion (200 g/kg) of the ground corn in a practical diet for broiler chickens. Feeding PW at a rate of up to 200 g/kg resulted in optimum biological response and monetary returns. The inclusion of PW at a rate of up to 300 g/kg in the diets did not increase wetness of the litter or hardness of pellets, two factors reported earlier that could limit the use of PW in animal diets.

STORAGE AND PROCESSING

Apple softening suppressed by readdition of a partly purified extract. Ground apple pomace extracted with ethylacetate was concentrated and purified for a specific α-galactosidase inhibitory function. Vacuum infusion of either H_2O or the extract had no significant effect on fruit soluble solids or on titratable-acid level in apples held at shelf temperature. Vacuum infusion of the extract containing approximately 100 units of β-galactosidase inhibitor per millilitre retained fruit firmness in McIntosh and Gravenstein apples held at 20°C ($P < 0.01$).

Effects of modified fruit and leaf weight loss on apple mineral content and firmness loss in storage. Applications of an antitranspirant (8% v/v Vapor Gard) to leaves decreased concentrations of N, P, Mg, and Ca in leaves, decreased dry-matter content of apples, and decreased mass and amount of Ca per apple, but increased fruit firmness at harvest and after 120 days of air storage at 0°C. Surfactant applications (8% v/v Tween 20) to fruit decreased fruit mass and N and Mg concentrations in leaves, but increased both dry-matter content of fruit and firmness after storage. Since selective application of either an antitranspirant or a surfactant to leaves or fruit, respectively, to modify the water-loss balance between the fruit and leaves did not increase Ca concentrations in fruit, increased fruit firmness was probably a result of reduced fruit mass and increased dry-matter content.

Inhibition of β-galactosidase isolated from McIntosh apples. β-Galactosidase activity was dependent upon preparation method with acetone powders showing 3–10 times the activity as compared with freeze-dried powders or fresh homogenates. Readdition of the partly purified acetone extract to acetone powders reestablished the enzymatic inhibition. This preliminary evidence suggests the presence of a nonvolatile inhibitor that may be capable of regulating β-galactosidase activity in vivo.

Modification of storage temperature and controlled atmosphere to reduce overwintering population of eggs of European red mite on McIntosh apples. The mortality of eggs of

European red mite (*P. ulmi*) on McIntosh apples in storage increased with continuing exposure to low O_2 (1.0% CO_2 + 1.0% O_2) or conventional controlled atmosphere (CCA, 5.0% CO_2 + 3.0% O_2) and with storage temperature elevated to 7.5°C. Lethality was sufficient to provide commercial control for overwintering populations. Susceptibility of eggs of red mite varied among years and among orchards within years. Some of the variation can be attributed to differences in resistance among mite populations.

Ethylene removal by potassium permanganate on several carriers. Removal of ethylene (C_2H_4) from an air sample by $KMnO_4$ was more efficient on a per-volume-of-packing basis for two commercial products and a laboratory-made product using aluminum oxide (Al_2O_3) pellets as a carrier than for $KMnO_4$ crystals seeded on expanded glass cubes. However, the smaller Al_2O_3 pellets had greater resistance to air flow and were more expensive than expanded glass packing. Higher air temperature increased the efficiency of all carriers studied. Higher air humidity increased removal of C_2H_4 by $KMnO_4$ crystals on expanded glass, but the resulting higher moisture content decreased the removal for $KMnO_4$ on Al_2O_3. Airstream flow was negatively related to C_2H_4 removal efficiency, whereas acidic or alkaline $KMnO_4$ dipping solutions increased C_2H_4 removal. Smaller expanded glass cubes increased overall surface area-to-volume ratios and increased C_2H_4 removal.

Effect of cultivar, modified atmosphere, and rapeseed oil on ripening and decay of mature green tomatoes. Mature green fruit of tomato (*Lycopersicon esculentum* Cabot and Cal J) were stored at 13°C in air or in a modified atmosphere (MA) formed by sealing five fruits in a 25.4-μ low-density polyethylene bag. Modified-atmosphere fruit ripened more slowly and decayed less than fruit ripened in air. Cal J fruit had a higher dry-matter content, ripened more slowly, decayed less, and produced MA atmospheres with 2% lower carbon dioxide and 17 μL/L less ethylene than Cabot. Weight losses in storage were measured. The main rot organisms were *Alternaria alternata* and *Fusarium* spp. Coating the stem scars with rapeseed oil had little effect on ripening and resulted in more *Penicillium expansum* rot. MA storage could extend the period for the marketing of field crops.

Mechanical decapping of strawberries. The performance of a mechanical decapper was evaluated during the 1983 strawberry season. Over all the runs, an average of 74% of the fruit was successfully decapped, although it ranged from 54% to 91% for any cultivar–harvest date combination. Percentage of "rollovers" was relatively constant at about 2% over all the runs. Decreases in percentage of decapped berries were accompanied by a corresponding increase in percentage of "rollbacks." Similarly, increases in feed rates decreased the percentage of decapped berries and increased the percentage of rollbacks. Stem length explained 43.6% of the variation among trials. Stem diameter had no effect on explaining differences among runs. Percentage of rollbacks was not directly related to the number of berries without stems in the sample, although pickers did observe that Raritan was extremely difficult to pick with stems on. For the six cultivars evaluated on 5 July and 12 July, 13.2% more fruit was finished on 5 July than on 12 July. The later harvest produced less finished fruit for all cultivars evaluated and was probably a result of the higher feed rate. Differences among cultivars were not significant in this survey; many more samples would have to be tested before differences among cultivars could be detected with precision.

Flotation separation of moss from lowbush blueberries. New markets for lowbush blueberries, particularly in Japan, have required the production of a higher quality frozen blueberry pack, with a reduced foreign material content, specifically moss and earth clumps. A flotation separation system based on the difference in density between the berries and foreign material was tested at one blueberry plant over two seasons. The moss content of frozen packed lowbush blueberries was reduced with the use of a high-density solution of salt or sugar.

Milling and baking quality of Nova Scotia winter wheat. Characteristics of milling and baking quality were evaluated during 1983. From this it was found that Vuka is not a milling-quality wheat. Even under intensive cultural conditions, the Farinograph values are unacceptable from a milling point of view. Loaf volume reflects the weakness of the flour, and the extraction rate is significantly lower than that obtained with the other varieties. The extensive cultural treatment in no case produced a milling-quality wheat. The protein level in both the grain and the flour was significantly lower than the protein levels obtained with all the intensive treatments. Similarly, the Farinograph data, with the exception of absorption, are significantly poorer. Certain quality features of Absolvent were superior to those of Monopol. Mean for all treatments indicated that Absolvent produced significantly higher meal and flour proteins and significantly higher absorption characteristics, though all other Farinograph properties were approximately equal. All intensive treatments produced milling-quality wheat when applied to a cultivar with inherent milling characteristics.

PUBLICATIONS

Research

Anderson, M. G. 1983. A long-term model for plant disease host-pathogen simulation. Ecol. Modelling 20:201-222.

Anderson, M. G.; Poapst, P. A. 1983. Effect of cultivar, modified atmosphere and rapeseed oil on ripening and decay of mature-green tomatoes. Can. J. Plant Sci. 63:509-514.

Blatt, C. R. 1983. Management practices on marketable yields of lowbush blueberry. HortScience 18:938-940.

Craig, D. L.; Cutcliffe, J. A.; McRae, K. B. 1983. Effect of plant thinning and row width on yield and fruit size of three strawberry cultivars in Atlantic Canada. Adv. Strawberry Prod. 2:1-6.

Hall, I. V. 1983. Genetic improvement of the lowbush blueberry, *Vaccinium angustifolium*. Can. J. Plant Sci. 63:1091-1092.

Hall, I. V.; Craig, D. L.; Lawrence, R. A. 1983. A comparison of hand raking and mechanical harvesting of lowbush blueberries. Can. J. Plant Sci. 63:951-954.

Hardman, J. M.; Mukerji, M. K. 1982. A model simulating the population dynamics of the grasshoppers (Acrididae) *Melanoplus sanguinipes* (Fabr.), *M. packardii* Scudder, and *Camnula pellucida* (Scudder) Res. Popul. Ecol. 24:276-301.

Herbert, H. J.; Hamilton, D.; Garbor, G. 1983. Sampling leaves to estimate the density of brown mite, *Byrobia rubrioculus* (Acarina: Tetranychidae) on apples. Can. Entomol. 115:1229-1231.

Herbert, H. J.; McRae, K. B. 1983. Effect of temperature on the emergence of overwintering *Phyllonorycter blancardella* (Lepidoptera: Gracillariidae) and its parasite *Apanteles ornigis* (Hymenoptera: Braconidae) in Nova Scotia. Can. Entomol. 115:1203-1208.

Hicklenton, P. R. 1983. Flowering, vegetative growth and mineral nutrition of pot chrysanthemums in sawdust and peat-lite media. Sci. Hortic. 21:189-197.

Hulan, H. W.; Proudfoot, F. G.; Zarkadas, C. G. 1982. Potato waste meal. I: Compositional Analysis. Can. J. Anim. Sci. 62:1161-1169.

Hulan, H. W.; Proudfoot, F. G.; Zarkadas, C. G. 1982. Potato waste meal. II: The nutritive value and quality for broiler chickens. Can. J. Anim. Sci. 62:1171-1180.

Ivany, J. A.; Sadler, J. M.; Kimball, E. R. 1983. Rate of metribuzin breakdown and residue effects on rotation crops. Can. J. Plant Sci. 63:481-487.

Jensen, K. I. N.; Ivany, J. A.; Kimball, E. R. 1983. Efficacy of three dinitroaniline herbicides in processing peas and their residues in soils. Can. J. Plant Sci. 63:687-693.

Lidster, P. D.; Lightfoot, H. J.; McRae, K. B. 1983. Fruit quality and respiration of McIntosh apples in response to ethylene, very low oxygen and carbon dioxide storage atmospheres. Sci. Hortic. 20:71-83.

Lidster, P. D.; Lightfoot, H. J.; McRae, K. B. 1983. Production and regeneration of principal volatiles in apples stored in modified atmospheres and air. J. Food Sci. 48:400-402, 410.

Lidster, P. D.; Webster, D. H. 1983. Effects of modified fruit and leaf water loss on apple mineral content and texture loss in storage. HortScience 18:924-926.

Major, D. J.; Bootsma, A.; Brown, D. M.; Dupuis, G.; Fairey, N. A.; Grant, E. A.; Langille, J. E.; Sonmor, L. G.; Smeltzer, G. G.; White, R. P. 1983. An evaluation of the corn heat unit system for the short-season growing region across Canada. Can. J. Plant Sci. 63:121-130.

McRae, K. B.; White, R. P. 1983. A multivariate approach for the selection of cultivars with antagonistic traits. Can. J. Plant Sci. 63:861-870.

Poapst, P. A.; Anderson, M. G. 1983. Preharvest defoliation of rutabaga with ammonium peroxydisulphate and ethephon. J. Hortic. Sci. 58:97-101.

Proctor, J. T. A.; Crowe, A. D. 1983. Response of apple growth and flowering to shade and ground covers. HortScience 18:470-472.

Proudfoot, F. G.; Hulan, H. W. 1983. Effects of dietary aspirin (acetylsalicylic acid) on the incidence of sudden death syndrome and the general performance of broiler chickens. Can. J. Anim. Sci. 63:469-471.

Proudfoot, F. G.; Hulan, H. W.; McRae, K. B. 1983. Effect of feeding poultry diets supplemented with rapeseed meal as a primary protein source to juvenile and adult meat breeder genotypes. Can. J. Anim. Sci. 63:957-965.

Proudfoot, F. G.; Hulan, H. W.; McRae, K. B. 1983. The effect of feed denial in starter diets on the performance of broiler chickens. Poult. Sci. 62:1915-1917.

Ragab, M. T. H.; Abdel-Kader, M. H. K.; Ivany, J. A. 1983. Residues of carbofuran and its two carbamate metabolites in field-treated rutabaga. J. Environ. Sci. Health Part B 18(2):301-304.

Ragab, M. T. H.; Everett. C. F.; DeMarco, C. A. 1983. Analysis of potatoes treated with dinoseb and chlorbromuron herbicides. J. Agric. Food Chem. 31:449-451.

Ramaswamy, M. A.; Tung, M. A.; Stark, R. 1983. A method to measure surface heat transfer from steam/air mixtures in batch retorts. J. Food Sci. 48:900-904.

Read, D. C.; Gaul, S. O. 1983. Movement and residual toxicity of carbofuran in acid mineral soil. Agric. Ecosystems Environ. 9:57-68.

Ross, R. G.; Delbridge, R. W.; Kimpinski, J.; McRae, K. B. 1983. Control of apple replant disease in Nova Scotia by soil fumigation with Corlex and chloropicrin. Can. J. Plant Pathol. 5:177-180.

Smith, J. P.; Jackson, E. D.; Ooraikul, B. 1983. Microbiological studies on gas-packaged crumpets. J. Food Prot. 36:279-283.

Smith, J. P.; Jackson, E. D.; Ooraikul, B. 1983. Storage study of a gas-packaged bakery product. J. Food Sci. 48:1370-1375.

Van Lunen, T. A. 1983. Effect of rearing weaner pigs at three stocking densities on raised decks or solid flooring. Can. J. Anim. Sci. 63:731-734.

Webster, D. H. 1983. Relationships between Mg, K and Ca of apple fruit. J. Plant Nutr. 6:751-758.

Wood, G. W.; Crozier, L. M.; Neilson, W. T. A. 1983. Monitoring the blueberry maggot, *Rhagoletis menda* (Diptera: Tephritidae), with Pherocon AM traps. Can. Entomol. 115:219-220.

Miscellaneous

Hulan, H. W.; Proudfoot, F. G.; McRae, K. B. 1983. Replacement of soybean meal and rapeseed (canola) meal in the diets of juvenile and adult meat breeders. Proceedings 6th International Rapeseed Conference, Paris, France.

Ivany, J. A.; Sadler, J.; Kimball, E. R. 1983. Effect of Sencor 50 WP on crops following potatoes. Canadex 649.

Jensen, K. I. N.; Doohan, D.; Thomson, J. 1983. Hexazinone: A new herbicide for lowbush blueberries. Canadex 235.641.

Lidster, P. D. 1983. Low oxygen storage of McIntosh apples. N.Y. State Hortic. Soc. Proc. 128:48-54.

Lidster, P. D. 1983. Recognizing and resolving postharvest disorders of apples and pears. Proc. N.S. Fruit Growers Assoc. 119:104-111.

Lockhart, C. L.; Delbridge, R. W.; McIsaac, D. 1983. Observations on Monilinia twig and blossom blight of the lowbush blueberry in the Maritime Provinces. Can. Plant Dis. Surv. 63:31-34.

Lord, F. T. 1983. The development of agricultural entomology in Nova Scotia. Proc. N.S. Inst. Sci. 33:19-46.

Read, D. C.; Gaul, S. 0. 1983. Adaptive microorganisms break down insecticides. Can. Agric. 28:28-30.

Webster, D. H.; Topp, G. C. 1983. Measurement of capillary rise under field conditions and related soil properties. Agric. Can. Res. Branch Tech. Bull. 1984-19E, Kentville Res. Stn. Tech. Bull. No. 3. 41 pp.

Fredericton Research Station
Fredericton, New Brunswick

PROFESSIONAL STAFF

C. S. Bernard, B.S.A., M.Sc., Ph.D.	Director
L. W. Garber, B.A., M.Ed.	Administrative Officer
D. B. Gammon,[1] M.A.	Library Area Coordinator
R. C. Hurtubise, B.Sc.	Information Officer
N. Taniguchi,[1] B.L.S.	Librarian
D. A. Young, B.Sc., M.Sc., Ph.D.	Officer in Charge, Benton Ridge

Horticulture—Potatoes

R. H. Bagnall, B.Sc., M.Sc., Ph.D.	Virus epidemiology and resistance
G. Boiteau, B.Sc., M.Sc., Ph.D.	Insect ecology
M. C. Clark, B.Sc., Ph.D.	Biochemistry of disease resistance
R. H. Coffin, B.Sc., M.Sc., Ph.D.	Breeding and evaluation
W. K. Coleman, B.Sc., Ph.D.	Physiology
H. De Jong, B.A., M.S., Ph.D.	Diploid breeding and genetics
W. A. Hodgson, B.Sc., M.Sc.	Late blight
R. R. King, B.Sc., M.Sc., Ph.D.	Residue chemistry
A. R. McKenzie, B.Sc., M.Sc., Ph.D.	Tuber-borne pathogens
C. D. McLeod, B.A.Sc., M.A.Sc.	Agricultural mechanization engineering
G. C. Misener, B.Sc., M.Sc., Ph.D.	Harvesting and storage engineering
A. M. Murphy, B.Sc., M.Sc.	Disease screening
Y. Pelletier,[2] B.Sc., M.Sc.	Insect–plant relationships
J. E. A. Seabrook, B.Sc., M.Sc., Ph.D.	Propagation methods
R. P. Singh, B.Sc., M.Sc., Ph.D.	Virus diseases, viroids
G. C. C. Tai, B.Sc., M.Sc., Ph.D.	Quantitative genetics
T. R. Tarn, B.Sc., Ph.D.	Cytogenetics
D. A. Young, B.Sc., M.Sc., Ph.D.	Breeding and genetics

Horticulture—Fruit

E. N. Estabrooks,[3] B.Sc., M.Sc.	Tree fruits and berry crops
C. D. McLeod, B.A.Sc., M.A.Sc.	Agricultural mechanization engineering

G. W. Wood, B.Sc., M.A., Ph.D.	Blueberry pests
L. Woodrow,[4] B.Sc., M.Sc.	Fruit crop winterhardiness

Soils Conservation and Management

T. L. Chow, B.Sc., Ph.D.	Soil hydrology
A. A. MacLean, B.Sc., M.Sc., Ph.D.	Soil chemistry and environmental quality
J. E. Richards,[5] B.Sc., M.Sc.	Soil fertility
G. R. Saini, B.Sc., M.Sc., Ph.D.	Soil physics

Animal Nutrition and Livestock Feeds

P. L. Burgess, B.Sc., M.Sc., Ph.D.	Dairy cattle nutrition
R. S. Bush,[6] B.S.A., M.Sc., Ph.D.	Calf nutrition
R. E. McQueen, B.Sc., M.Sc., Ph.D.	Rumen microbiology
J. W. G. Nicholson, B.Sc., M.Sc., Ph.D.	Meat animal nutrition

Senator Hervé J. Michaud Experimental Farm, Buctouche, N.B.

R. Rioux,[7] B.Sc.	Acting Superintendent; Forage and cereal crops
P. V. Le Blanc,[8] B.Sc., B.S.A.	Vegetables
M. Luffman, B.Sc.	Fruits

Departures

W. A. Hodgson, B.Sc., M.Sc. Retired June 1983	Late blight
A. A. MacLean, B.Sc., M.Sc., Ph.D. Retired September 1983	Soil chemistry and environmental quality

---

[1] Seconded from Libraries Division, Finance and Administration Branch.

[2] Appointed June 1983.

[3] Appointed March 1983.

[4] Appointed May 1983, scientist in training.

[5] Appointed September 1983, scientist in training.

[6] Seconded to Management Accountability Directorate, April–October 1983; Program Coordination, October 1983–April 1984.

[7] Appointed April 1983; Seconded from La Pocatière Experimental Farm.

[8] On education leave, September 1983.

INTRODUCTION

The Fredericton Research Station carries a comprehensive research program on potatoes, focusing a multidisciplinary effort on cultivar development and evaluation, tuber processing quality, disease control, pest management, rapid multiplication techniques, dormancy manipulation, harvesting and storage procedures, and soil utilization. Recently, emphasis has been placed on the seed potato sector of the industry, through the testing of Canadian genetic stocks in countries with potential for importing and related research in phytosanitary quality.

The livestock and livestock feeds program has, as its main goal, the efficient utilization of locally produced feeds and particularly forages by ruminant animals. Herd and flock management is also investigated. This research is pursued in close collaboration with the Nappan Experimental Farm, in Nova Scotia.

The horticultural program consists of research on blueberry crop management and pest control, and contributes to the program at the Kentville Research Station on the management of apple orchards and the evaluation of strawberry cultivars. To the horticultural program is added the research conducted at the Senator Hervé J. Michaud Experimental Farm in Buctouche, N.B., which is pertinent to requirements in that geographical location. The Michaud Farm's research summary appears in this report.

Soil scientists at Fredericton contribute to the maintenance and improvement of the agricultural land base in New Brunswick, and the work of analytical chemists includes the monitoring of degradation and residue products of chemicals and pesticides used either on the soil or on crops.

The results herein reported provide an overview of continuing research programs. More complete information may be obtained from the Research Station, Agriculture Canada, Box 20280, Fredericton, N.B. E3B 4Z7.

C. S. Bernard
Director

POTATOES

Breeding

Improving maturity and marketable yield in hybrid families of Andigena potatoes. Hybrid families obtained by crossing Tuberosum breeding lines with adapted Andigena selections show heterosis for total yield but have late maturity and low marketable yields. When Tuberosum lines are used as female parents, the fertility of the progeny is generally very low.

Analysis of five pairs of reciprocal crosses shows that the Tuberosum × Andigena families differ significantly from the reciprocals by having more vigor, earlier maturity, greater total yield, and smaller marketable yield. The Andigena × Tuberosum families are twice as fertile as the reciprocals, as measured by natural berry set in the experimental field. In relation to Tuberosum cultivar checks, both sets of families have unacceptable late maturity and low marketable yield.

To evaluate backcrossing as a means of improving maturity and marketable yield, six Tuberosum × Andigena clones were crossed with six different Tuberosum cultivars as males. In relation to their Tuberosum backcross parents the backcross families had similar maturity, 14% greater total yield, and 6% greater marketable yield. This performance shows the gains that can be achieved by this breeding strategy.

Genetic advance in breeding on the diploid level. Theoretically, it is expected that as a result of their disomic inheritance pattern, the genetic advance would be more rapid among (cultivated) diploids than among (cultivated) tetraploids that have a tetrasomic inheritance pattern. In the diploid breeding project, clones are selected on the basis of traits such as tuber type, tuber size, specific gravity, maturity, and type of foliage. Several advanced diploid breeding stocks, derived from (*Solanum tuberosum* L.) Groups Phureja or Stenotomum × group Tuberosum haploids, have been identified, which approach commercial cultivars in marketable yield and several other horticultural traits. These results confirm the theoretical expectations for a relatively rapid genetic advance among (cultivated) diploids.

The genetic consequence of 2n *gametes in tetraploid–diploid crosses.* The discovery of diploid hybrids that produce 2*n* unreduced gametes leads to a new dimension in the genetic and breeding research for the potato. These hybrids were obtained by crossing the haploids of the tetraploid cultivated potato (*S. tuberosum* L.). There are two types of 2*n* gametes that are produced by first-division restitution (FDR) and second-division restitution (SDR) during meiosis, respectively. A theoretical study is conducted to examine the genetic consequence of the FDR and SDR gametes in the progenies of tetraploid–diploid (4×–2×) crosses based on the principles of biometrical genetics. It is indicated that a 4×–2× (FDR) cross produces higher frequency of heterozygous genotypes than does an equivalent 4×–4× cross. If a complete or overdominance model is assumed, the 4×–2× (FDR) hybrids give a higher mean and a reduced genotypic variance for a polygenic trait when compared with the mean and variance of 4×–4× hybrids. The SDR gametes show opposite behavior when a gene is located close to the centromere of a chromosome. The genetic consequences of FDR and SDR, however, tend to converge when a gene is located away from the centromere.

Assessing response patterns of seedlings and cultivars to a specific disease in field studies. Seedlings and cultivars always must be classified according to their response to a specific disease in field studies. Multiple observations of disease damage are often made for such diseases as late blight, for the sake of recording the rate of disease development. A multiple comparison procedure is often used to classify seedlings and cultivars into groups. But such a procedure is not appropriate for analyzing and interpreting repeated measurements or response curves data. It is proposed that a principal component analysis (PCA) be applied to these types of data. Analysis of variance is carried out on the first few important PCA varieties. A multiple comparison procedure is then followed to group the seedlings and cultivars, based on the important PCA variates. Application of the method to several late blight experiments showed satisfactory results in classifying seedlings and cultivars into discrete groups.

Resistance to common scab (Streptomyces scabies). Field trials to evaluate breeding material for resistance to common scab (*S. scabies*) have been conducted in a disease nursery maintained at the Fredericton Research Station for over 20 yr. The 1983 trial contained 96 F-numbered seedlings from the variety development program as well as standard check varieties. It was the second test for 19 of these seedlings and the values, for the most part, corresponded closely to those from the year before; 11 had moderate levels of resistance to scab. In addition, 97 clones from haploid, diploid, and tetraploid *S. andigena* breeding collections were evaluated. Several had high levels of resistance for the 2nd yr. Crosses have been made that aim to combine increased scab resistance with acceptable yield and horticultural characteristics.

Pathology

Plasmids from (Corynebacterium sepedonicum). An attempt was made to determine the feasibility of developing a rapid, sensitive, and specific test for detecting bacterial ring rot, based on the application of bio-dot hybridization techniques to plasmids associated with the bacterium. Nine different screening and isolation procedures were evaluated for their efficiency in recovering plasmids from seven widely divergent isolates of the ring rot organism. Lysis of bacterial cells with sodium dodecyl sulfate or sarkosyl in alkaline solution, followed by electrophoresis of the crude lysates or ethanol-precipitated material in 0.7% agarose gels and ethidium bromide staining, revealed the presence of a 60-megadalton plasmid that was common to all isolates. Some of the isolates showed several plasmids, ranging in size from about 30–120 megadaltons as determined by a comparison of their gel mobilities to eight reference plasmids from a multiplasmid strain of *Escherichia coli*. (The covalently closed circular forms of these reference plasmids ranged from 36 to 1.4 megadaltons, based on gel mobility and on electron microscopic analysis.)

Restriction enzyme mapping, cross hybridization, and electron microscopic studies are currently in progress.

Solanum berthaultii, a sensitive host for indexing potato spindle tuber viroid from dormant tubers. When infected with mild or severe strains of potato spindle tuber viroid (PSTV), *S. berthaultii* was found to develop severe symptoms consisting of necrotic spotting on petioles and main stems, along with leaf collapse. The necrotic, rolled leaves eventually dry out, but do not drop or abscise. Any new leaves are reduced in growth, and the entire plant is severely stunted. Symptoms occur with inoculation of sap from potato foliage, sprouts, or tubers. Tubers can be tested either by rubbing with the cut surfaces of the suspect tuber directly onto the leaves or rubbing with an extract of nucleic acid. Crude tuber extract proved unsatisfactory; however, crude sprout extract was as good as tuber-nucleic acid extract. Infection of PSTV in tubers could be detected from as little as 7–31 mg of infected tissue in 2 g of healthy tuber tissue. This ratio of infected to healthy tissue is equivalent to one infected tuber mixed with 255–263 healthy tubers. With the use of *S. berthaultii*, PSTV was detected from tubers obtained from potato plants that were inoculated with very dilute PSTV inoculum, thus showing this species' suitability for detecting PSTV from potato plants infected in the current year. In a survey of field-grown PSTV-suspected tubers, PSTV was detected from tubers infected with either mild or severe strains of PSTV.

S. berthaultii is easy to propagate by cuttings, and a clone (No. 26) developed in this study is uniform in growth and its reaction to PSTV.

Reactions of tuber-bearing Solanum species to infection with potato spindle tuber viroid. A total of 555 plant introductions belonging to 81 tuber-bearing *Solanum* species were evaluated in greenhouse or field tests for their reaction to mild and severe strains of PSTV. Plants tolerant of PSTV were found, but none were found to be immune. Although most plants of all species displayed diagnostic symptoms, symptomless plants were observed in 38 species, and none of the inoculated plants in 17 of the introductions developed symptoms. Primary symptoms consisted of stunting of whole plants, reduced leaf size, and necrosis of petioles, leaf veins, and stems. Clonal propagation of selected plants that develop diagnostic symptoms upon inoculation with both mild and severe strains of PSTV is useful for bioassay purposes.

A local lesion host for potato virus Y useful in field epidemiological studies. The potato (*S. tuberosum* L.) cultivar Jemseg was shown to develop local lesions when inoculated with potato virus Y (PVY). Local lesions were produced by both aphid and mechanical inoculation in the field and in the greenhouse. Local lesion production was not affected by the presence of potato viruses A, S, X, or PSTV. The potato-infesting aphids *Aphis nasturtii* Kaltenbach and *Myzus persicae* (Sulzer) transmitted PVY to Jemseg plants, but no PVY was transmitted to Jemseg by the aphids *Aulocorthum solani* (Kaltenbach) or *Macrosiphum euphorbiae* (Thomas). Transmission of PVY to Jemseg by aphid species was similar to that obtained on Russet Burbank potato or *S. demissum* plants but different from that on the tobacco plants. In view of these differences in aphid transmission of PVY to potato and tobacco, the use of tobacco as a "bait" plant may not be satisfactory in detecting PVY in the field.

Entomology

Chemical control. Systemic insecticides can be applied in three different manners. Most New Brunswick potato growers apply them in the fertilizer band and the others put them in the seed furrow. In some American states, aldicarb must be applied as a topdress. Tests were conducted to compare the effectiveness of the three methods under New Brunswick conditions for aldicarb and disulfoton at 10, 17, and 22 kg/ha.

In all cases, seed furrow applications were consistently and often significantly superior to fertilizer-band applications for the control of the Colorado potato beetle. Topdressing provided poor control early in the season, but by August it was as effective as the seed furrow application. Leaf analyses to determine plant uptake at various times throughout the growing season supported this finding. The concentration of aldicarb in potato leaves was consistently higher in seed furrow applications and lower in topdressing ones, regardless of rate. The seed furrow application is recommended.

Insecticide resistance. Between 1974 and 1979, adult Colorado potato beetles were sighted in only 18% (average) of fields in New Brunswick, but between 1980 and 1983, the rate increased to 70%. Tests were undertaken to determine if this sudden increase could be related to the occurrence of insecticide resistance. In 1983, a Fredericton population of the beetle was found to have a slight tolerance for carbofuran and fenvalerate but this was not serious enough to indicate the development of resistance to insecticides. In 1983, the same population showed a greater tolerance, although carbofuran applied at the recommended rate was still controlling the beetles. Insects collected in the Bloomfield area had a degree of tolerance similar to that of Fredericton beetles in 1982. However, tests conducted on beetles from a field where carbofuran had been reported ineffective, in the Mapledale area, revealed a population with a high level of resistance. The presence of carbofuran-resistant beetles in at least one locality in New Brunswick and its increasing tolerance in another suggest that the Colorado potato beetle could be back as a primary pest of potatoes.

Colorado potato beetle. In the course of studies on the pheromones of the Colorado potato beetle, a large colony of this species had to be maintained. A rearing method was needed that could produce batches of 500–700 beetles less than 1 wk old and with synchronized emergence. By exposing eggs at various low temperatures, we determined that it was possible to hold them at 10°C for up to 12 days without affecting survival. In this way, eggs could be accumulated until needed for a specific experiment or until sufficient numbers had been collected from potato fields or a laboratory colony.

Ground arthropods. A 3-yr faunal survey of potato fields in New Brunswick revealed that Carabidae were the most abundant ground arthropods, followed by Arachnida and Staphylinidae. With the use of rows of pitfall traps, it was determined that these arthropods are distributed along a gradient that decreases with distance from the edge of the field closest to the woodland. According to these data, their effectiveness as predators of potato insect pests are affected by the size of the field and the presence or absence of woodland nearby.

Propagation

Vegetative propagation of potatoes. Propagation of potatoes by stem cuttings can be improved by the use of a concentrated rooting hormone. The cuttings treated with hormone root 5 days earlier than nontreated cuttings. Hormone-treated cuttings have many roots on the lower 3 cm of the petiole, whereas nontreated cuttings only have 2–5 roots at the end of the petiole. A rooting medium with good drainage, such as vermiculite and perlite (1:1), increased cutting survival. Trimming leaves off the stem cuttings was found to be deleterious to cutting survival, and thus intact cuttings were used routinely. Pruning or shading the apical shoot of the mother plant promoted the flushing of axillary shoots. A mist propagation system of 50% Shade Cloth increased the survival of the cuttings by reducing wilting.

Tuberization of potato leaf bud cuttings was partly dependent upon the age of the mother plant when the cuttings were prepared. The day length to which these cuttings were exposed also influenced tuberization. When leaf bud cuttings of Caribe, Katahdin, Kennebec, Red Pontiac, Russet Burbank, Sable, and Shepody were exposed to short days (8 h), tuberization occurred earlier and tuberlets were larger compared with cuttings of the same varieties exposed to long days (16 h). The cultivar Jemseg, an early potato, had maximum tuberization when cuttings were exposed to long days. Fertilizing the cuttings with a foliar fertilizer prolonged the life of the leaf bud cuttings and resulted in larger tuberlets.

Fifteen potato cultivars were established in vitro in the tissue-culture-growth room at Fredericton. Although there were some varietal differences in response to culture conditions, all cultivars grew well on a minimal salt solution with organic supplements. Certain types of test-tube closures appear to change the growth of potato multiplication cultures, and the reasons for this are being investigated. The addition of 1–3% activated charcoal increased multiplication rates.

Physiology

Chemical manipulation of tuber dormancy. The tubers of most North American potato cultivars are dormant at the time they are required by early export seed markets. Previous experiments have indicated that the alkyl halide bromoethane is consistently effective in significantly reducing duration of tuber dormancy and in promoting subsequent sprout production and growth rate.

A small-scale trial with bromoethane indicated that a second fumigation of Kennebec tubers reduced dormancy duration and led to a tripling of both mean number of emergent stems and mean shoot growth rate relative to the results from a single bromoethane treatment. A third application was without additional effect.

Iodoethane, a chemical previously described in the literature as possessing dormancy-breaking capability, was without effect when tested over a wide concentration range. In the presence of bromoethane, it was without beneficial effect.

Drought stress and the potato plant. The potato plant is very sensitive to mild drought stress. This sensitivity is partly a result of the fact that approximately 70% of the total water uptake usually occurs in the upper 30 cm of the soil profile. An analysis of long-term weather data indicates that New Brunswick may experience yield reductions due to relatively mild and short-term drought stress.

One approach to this problem is to decrease water loss from potato plant leaves during the tuber bulking phase, through the use of low-cost antitranspirants that may work by obstructing water loss through the stomata and cuticle. Preliminary results with the antitranspirant Vapor Gard applied as a 1% solution gave a 25% yield increase (fresh weight) in No. 1 tubers during 1982 and an 8% yield increase during 1983. This approach may be an effective method of decreasing the detrimental effects of periods of short-term drought stress and may be preferable to the high-cost alternative of irrigation.

ANIMAL NUTRITION AND LIVESTOCK FEEDS

Beef growing–fattening systems

Five beef growing–fattening systems for spring-born beef calves were compared over 3 yr. The systems, based on computer simulations made at the Charlottetown Station, ranged from high-energy diets based on barley or potatoes to high-forage diets from weaning to slaughter. Several periods of backgrounding to give gains of 0.5–0.75 kg/day, followed by feedlot or pasture finishing, were included.

At the prices prevailing during the study, the system most likely to make money made use of high-energy diets based on cull potatoes from weaning to slaughter. The second best returns over the 3 yr were obtained with the system that used backgrounding over the winter and finishing on pasture, with limited grain in the final weeks on pasture. The system least likely to make money used backgrounding to gain 0.5–0.75 kg /day for 3–6 mo, followed by feedlot finishing on silage and barley diets.

Implant comparison

Steers implanted with Synovex or Ralgro implants were compared over six 28-day periods for rate of gain, feed consumption, and efficiency of feed conversion to weight gain. The implants were placed according to directions from the supplier. Over the 168-day trial, the Synovex-implanted steers gained slightly more (9 kg) and converted feed to weight gain more efficiently (5.8 versus 6.l), but only in the first 28-day period were the differences statistically significant.

Fish meal with grass silage

Grass silage contains enough crude protein to meet the requirements of most beef cattle as set out in nutrient requirement tables. However, much of the crude protein is not true protein and may not be efficiently used. There are numerous reports of supplemental true protein improving weight gains and feed conversion by animals fed high-silage diets. Theoretically, a protein source such as fish meal, which is not readily degraded in the rumen and which gives a desirable amino acid balance when digested in the intestines of the animals, would be ideal as a silage supplement.

A trial was carried out with beef calves fed diets based on grass silage (11.5% crude protein in the dry matter). Half of the calves received a supplement based on soybean meal and the others a supplement based on fish meal. The supplements were formulated to be isonitrogenous, but on analysis, the one containing soybean meal was slightly higher (27.9 versus 27.2% crude protein). The weight gains and efficiency of feed conversion were almost identical for the calves fed the two supplements over the 168-day trial. All calves received crude protein (about 0.75 kg/day) in excess of their requirements (0.61–0.63 kg/day). If there is any advantage of fish meal over soybean as a supplement to grass-silage-based diets, it will be necessary to use lower protein diets to demonstrate the benefit.

Processing and protein supplementation of early and late hay

Timothy hay was harvested from two areas of the same field on 20 June (early cut) when the heads were still in the boot stage of development and on 17 July (late cut) at the late bloom stage. The crude protein content was 10.4 and 4.6%, respectively. The hays were fed ad libitum, either long (as taken from rectangular bales) or ground (through a 0.6-cm screen of a hammer mill). Each form of hay was fed to beef heifer calves with a barley-based supplement containing additional crude protein from either urea or soybean meal.

The calves fed the long, late hay consumed more hay dry matter (2.4% of body weight per day) than expected for hay of this quality. However, their average daily gains (0.4 kg) were less than for the calves fed the long, early hay (0.58 kg). Daily intake and weight gains were increased by grinding and by providing supplementary protein as soybean meal rather than as urea. The response to both grinding and soybean meal was similar for both the early- and late-cut hays.

Ryegrass pastures for dairy cows

Previous work has established the high productivity of ryegrass for pasture use. However, a comparison of Lemtal Italian ryegrass and native bluegrass pastures at similar levels of fertility with grazing dairy cows was desirable to evaluate the potential problems of low dry matter (DM) content and high nitrate levels in ryegrass.

A total of 225 kg/ha of actual nitrogen was applied to each pasture in split applications over the grazing season. In addition to pasture grass, all cows received a high-energy 14% dairy ration based on individual milk production. Cows in the ryegrass group were also offered 3.0 kg of timothy hay daily.

Forage DM percentages were higher (21.3 versus 13.8) for the native pasture than for the ryegrass, whereas the mean crude protein content was 18% for both pasture types. Nonprotein nitrogen in the form of ammonia or nitrates tended to increase later in the season, when the rate of forage growth slowed because of cold weather. The increase was greater for the native pasture than for ryegrass. Nitrates did not reach potentially harmful levels in either type of pasture.

Ryegrass permitted a 28% higher stocking rate with less supplemental barn feeding. Daily DM intake of pasture ranged from 8.5 to 13.9 kg per cow. Cows grazing ryegrass produced an additional 1.3 kg of milk per day with a higher protein and lactose content. However, milk fat was sharply reduced (0.4 percentage points).

It was concluded that ryegrass has good potential for late summer and fall grazing by dairy cows. It is readily consumed and withstands intensive grazing. Dairy operators are advised to feed adequate amounts of dried roughage in addition to ryegrass pasture to prevent milk-fat depression.

Effect of vomitoxin on fermentation by rumen microorganisms

Vomitoxin (deoxynivalenol) is a *Fusarium* species mycotoxin that is sometimes present in cereal grains harvested in Eastern Canada. We investigated the effect of vomitoxin on the extent of in vitro fermentation of cellulose (Whatman No. 1 filter paper) and timothy hay by rumen microorganisms. The fermentations were conducted anaerobically with a mixture of substrate, reduced media, and filtered rumen fluid. Vomitoxin concentrations in the complete fermentation mixture were tested up to 10 μg/mL and did not affect either cellulose or timothy hay digestion by rumen microorganisms in vitro. This concentration of vomitoxin exceeds that which would normally occur in the rumen of cattle fed contaminated grain.

The vomitoxin transformation product was isolated and purified, and its structure was established as that of a C-12 vinyl analogue. Efforts to determine whether the transformation constitutes a significant detoxification reaction are now under way.

FRUIT CROPS

Training systems for McIntosh apple trees

A comparison of fruit yield and quality for McIntosh, on six rootstock combinations and in three training systems, was made in the 13th yr of growth. The trees had been planted at a standard spacing of 1.8 m × 4.0 m and trained to the trellis, spindle-bush, or hedgerow system.

Highest yields, but lowest quality, were produced on the more vigorous rootstocks. Little yield differences were found between the dwarfing rootstocks M26, BA/M26, and 03/BA, or between the more vigorous rootstocks BA, MM106, and spur McIntosh/BA.

The vigorous stocks produced an average of 43% more fruit per tree when compared with the dwarfing stocks, regardless of the training system used.

The training system appeared to have little effect on fruit yield and quality from trees with dwarfing rootstocks, but did have a significant effect on yield and quality on the more vigorous trees. The greatest yields and highest quality were produced with the trellis system.

SOILS

Soil erosion in potato production

Soil erosion is the most severe and widespread soil degradation factor in New Brunswick because of inherent soil limitations and adverse climatic conditions, such as undulating to strongly rolling topography, dense subsoil, weak-structured surface soils, frequent freeze–thaw cycles, and high-intensity rainstorms. Massive soil losses associated with potato production in the upper Saint John River valley are of major concern.

Chemical analyses on runoff and sediment collected in 1982 indicate that approximately 20 and 10% of the N applied yearly was removed from potato plots located on 11 and 8% slopes, respectively. The corresponding N losses for fallow and grain on an 11% slope were 11 and 120 times less than the potato plot, respectively. Losses of K and Ca in potato plots were approximately 5 kg/ha, whereas P losses were less than 0.5 kg/ha.

Soil losses on 11% slopes during 1983 were 38.2, 1.8, 20.0, and 0.14 t/ha for potatoes planted up and down the slope, potatoes planted along the contour, fallow, and grain, respectively. It is important to note that more than 20 times less soil was lost in plots in which potatoes were planted along the contour rather than along the direction of the slope. In addition to the reduction in soil losses, potato yield was also 25% higher in plots where the crop was planted perpendicular to the slope.

Another test conducted during the winter of 1982 showed that soil losses can be reduced by as much as 60% by plowing the soil at a relatively low speed, to minimize the breakdown of large soil clods. The resulting surface roughness and the increased water retention capacity under such conditions reduce the amount of surface runoff and erosion.

Seasonal pattern of nutrient uptake by potatoes

In a study of nutrient uptake pattern by potatoes, plots of the cultivar Kennebec were sampled weekly over two growing seasons, and plants were analyzed for N, P, K, Ca, Mg, and Cl content. For the 2-yr period, average date of planting was 20 May, day of emergence was 2 June, and estimated date of tuberization was 2 July. As the average plot yields were high (57.9 t/ha) relative to those for commercial production, total nutrient uptake observed may be correspondingly high.

N uptake was very rapid in the immediate post-tuberization period, and by 30 July, 89% of the total N uptake had taken place. Uptake patterns for P, K, and Mg, and magnesium were similar, showing a relatively uniform increase throughout the growing season. P uptake declined only at the onset of maturation, whereas uptake of K peaked somewhat earlier (20 August). Ca and Cl uptake occurred early in the growing season and reached a maximum 2 wk after tuberization. Total uptake for N, P, K, Ca, Mg, and Cl was 183, 38, 450, 34, 22, and 68 kg/ha, respectively. Equivalent figures for P_20_5 and K_20 are 87 and 540 kg/ha, respectively.

Time of application of fertilizer nitrogen for potatoes

The long-term conventional method of fertilizer application for potatoes makes use of band placement at planting time. However, there is significant controversy among researchers over the appropriateness of this method and the time of application.

In our research on ways of increasing the efficiency of N fertilizer, time of application has been recognized as a potentially significant factor. Mean potato yields from a 3-yr study conducted on Riverbank sandy loam, a humo-ferric podzol, showed a significant response to N from an application of 135 kg/ha at planting. In that case, supplemental N applied as a side-dress treatment had no effect on yield, although the additional use of N on plots receiving 90 kg/ha of the element at planting did result in higher production. The response, however, reflected no specific pattern with respect to time of application or number of sidedress treatments. Supplemental rates of 22 and 44 kg/ha performed similarly. In addition, specific gravity of tubers was significantly lower with N treatments (180 and 225 kg/ha) made at planting time and with most sidedress treatments applied in conjunction with an initial application of 135 kg/ha, thus reflecting a delay in maturity of tubers under such conditions.

Under our soil and environmental conditions, and from the standpoint of all factors, including the economics of fertilizer application, it was concluded that a single application of N at planting time, to meet the total seasonal requirements of the potato crop, is a sound management practice.

SENATOR HERVÉ J. MICHAUD EXPERIMENTAL FARM BUCTOUCHE, N.B.

Vegetables

Plastic mulch. Yields of pickling cucumbers grown on black plastic mulch were increased by 24.5% compared with cucumbers grown on bare ground. Over a 2-yr period, the mean increase in yield was 2797 kg/ha for the cultivar Multipick and 6690 kg/ha for the cultivar Lucky Strike.

Clear polyethylene plastic with seedlings in 15-cm trenches increased the earliness of sweet corn by 15 days compared with corn grown on bare ground. The polyethylene mulch also improved the germination of the seeds by as much as 100%. The cultivar North Star under plastic produced 50% of its yield after 99 growing days, 15 days earlier than on bare ground. The cultivar Aztec under plastic produced 50% of its crop after 105 growing days, 9 days earlier than on bare ground. The use of clear polyethylene plastic with slits to allow corn seedlings to grow through also improved the earliness compared with bare ground, but not as much as plastic with seedlings in trenches.

Brussels sprouts. The cultivar Captain Marvel is a good alternative to the standard cultivar, Jade Cross. The cultivar Widgeon achieved the best yields but matured 14 days later than the cultivar Jade Cross. Widgeon is particularly attractive for the fresh market because it can be easily harvested by hand.

Fruits

Strawberries. Over a 3-yr period, the cultivar Kent had a mean yield of 19.7 t/ha compared with 11.7 t/ha for the standard cultivar, Redcoat. Under poor fertilization management, however, differences in yield between these two cultivars was only 2.0 t/ha. The yield of the late cultivar Bounty was shown to be inconsistent compared with Redcoat. Differences in yield were 6.9 t/ha in 1983 and 1.2 t/ha in 1981. In 1983, Bounty had the highest yield, but in 1981 it had one of the lowest in the recommended variety trial.

Raspberries. Cultivar evaluation has been carried out for 2 yr in the search for a relatively hardy cultivar suitable for the fresh market and pick-your-own operations. Of four cultivars tested, Festival is the best in terms of quality, appearance, flavor, and yield. Two other cultivars, Trent and Boyne, have high yields but lack flavor.

PUBLICATIONS

Research

Boiteau, G. 1983. The arthropod community of potato fields in New Brunswick, 1979-1981. Can. Entomol. 115:847-853.

Boiteau, G. 1983. Activity and distribution of Carabidae, Arachnida and Staphylinidae in New Brunswick potato fields. Can. Entomol. 115:1023-1030.

Boiteau, G.; Alford, A. 1983. Synchronization of Colorado potato beetle (Coleoptera: Chrysomelidae) emergence by temporary storage of eggs at low temperature. Can. Entomol. 115:1233-1234.

Brodie, B. B.; Rowberry, R. G.; Coffin, R. H. 1983. Resistance of the potato cv. Simcoe to the golden nematode, *Globodera rostochiensis.* Am. Potato J. 60:644.

Coleman, W. K. 1983. An evaluation of bromoethane for breaking tuber dormancy in *Solanum tuberosum* L. Am. Potato J. 60:161-167.

De Jong, H. 1983. Inheritance of sensitivity to the herbicide metribuzin in cultivated diploid potatoes. Euphytica 32:41-48.

King, R. R. 1983. Gas chromatographic determination of maleic hydrazide residues in potato tubers. J. Assoc. Off. Anal. Chem. 66:1327-1329.

Lynch, D. R.; Tai, G. C. C.; Young, D. A.; Schaaje, G. B. 1983. Effect of selection location on the efficiency of first clonal generation selection in a co-operative potato breeding program. Am. Potato J. 60:607-615.

Mazzucchi, U.; Bazzi, C.; McKenzie, A. R. 1982. Transmission of *Corynebacterium sepedonicum* from latently infected seed potatoes in the Po Valley. Phytopathol. Mediterr. 21(2-3):116-119.

Misener, G. C. 1983. Apparatus for measuring skinning resistance of potatoes. Can. J. Plant Sci. 63:1115-1117.

Reade, A. E.; McQueen, R. E. 1983. Investigation of white rot fungi for the conversion of poplar into a potential feedstuff for ruminants. Can. J. Microbiol. 29:457-463.

Rowberry, R. G.; Coffin, R. H. 1983. A comparison of four media for the production of tubers from leaf-bud cuttings in the greenhouse. Am. Potato J. 60:869-871.

Singh, R. P.; Somerville, T. H. 1983. Effect of storage temperatures on potato virus infectivity levels and serological detection by enzyme-linked immunosorbent assay. Plant Dis. 67:1133-1136.

Tai, G. C. C. 1983. Confidence intervals for genetic parameters in progeny test experiment in plant breeding. Can. J. Genet. Cytol. 25:502-508.

Tarn, T. R.; Tai, G. C. C. 1983. *Tuberosum* × *Tuberosum* and *Tuberosum* × *Andigena* potato hybrids: Comparison of families and parents, and breeding strategies for *Andigena* potatoes in long day temperate environments. Theor. Appl. Genet. 66:87-91.

Tarn, T. R.; Young, D. A. 1983. Acadia Russet: A new potato cultivar with excellent appearance and good culinary quality. Am. Potato J. 60:925-931.

Wood, G. W.; Crozier, L. M.; Neilson, W. T. A. 1983. Monitoring the blueberry maggot, *Rhagoletis mendax* (Diptera: Tephritidae), with Pherocon AM traps. Can. Entomol. 115:219-220.

Young, D. A.; Tarn, T. R.; Davies, H. T. 1983. Shepody: A long, smooth white-skinned potato of medium maturity with excellent French fry quality. Am. Potato J. 60:109-113.

Miscellaneous

Boiteau, G. 1983. Control of potato aphids and Colorado potato beetles with systemic insecticides——1982. Canadex 161.621.

Boiteau, G. 1983. The arthropod fauna of potato fields: Composition and abundance. Agric. Can. Res. Branch Tech. Bull. 1983-16E. 57 pp.

Coleman, W. K. 1983. Reduction of potato dormancy with bromoethane. Canadex 161.23.

McQueen, R. E. 1983. Biotechnology and agriculture. Canadex 020.

McQueen, R. E. 1983. Heat damage to forages. Canadex 120.65.

Murphy, H. J.; Morrow, L. S.; Young, D. A. et al. 1982. Performance evaluations of potato clones and varieties in the northeastern states. Maine Agric. Exp. Stn. Bull. 788. 171 pp.

Nicholson, J. W. G. 1983. Minerals for cattle on pasture. Canadex 401.64.

Nicholson, J. W. G. 1983. Using rye in animal rations. Canadex 400.52/117.

Nicholson, J. W. G. 1983. Beef production in the Atlantic Provinces. Agric. Can. Publ. 1494. 43 pp.

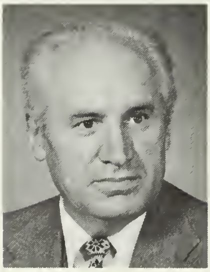
Singh, R. P. 1983. Viroids and their potential danger to potatoes in hot climates. Can. Plant Dis. Surv. 63:13-18.

Singh, R. P.; Santos-Rojas, J. 1983. Detection of potato virus Y in primarily infected mature plants by ELISA, indicator host, and visual indexing. Can. Plant Dis. Surv. 63:39-44.

Young, D. A.; Tai, G. C. C. 1983. Predicting yield performance. International Potato Centre. Research for the potato in the year 2000. Proceedings International Congress. International Potato Centre, Lima, Peru, pp. 191-192.

QUEBEC REGION
RÉGION DU QUÉBEC

Mr. J.-J. Jasmin



Dr. P. P. Lukosevicius

Mr. R. Boulanger

EXECUTIVE OF THE QUEBEC REGION
L'EXÉCUTIF DE LA RÉGION DU QUÉBEC

Director General
Directeur général
J.-J. Jasmin, B.Sc. (Agr.), M.Sc.

Program Specialist
Spécialiste en programmes
P. P. Lukosevicius, Diplomlandwirt, M.Sc., Ph.D.

Chief, Administration
Chef, Section de l'administration
R. Boulanger, L. Sces Adm., Adm.A.

PRÉFACE

La Région du Québec qui comptait trois stations de recherches, trois fermes expérimentales et cinq sous-stations expérimentales, s'est enrichie en 1983 d'un Centre de recherches alimentaires situé à Saint-Hyacinthe. L'aménagement et les constructions nécessaires à cette nouvelle unité prendront quelques années, mais ce centre nous permettra de réaliser des progrès appréciables dans le domaine de la recherche agricole et alimentaire. Le budget de la région ainsi que le personnel se sont maintenus au niveau des années précédentes tout en suivant la courbe normale de l'inflation. Les différents établissements de la Région du Québec poursuivent des programmes de recherches axés sur les priorités nationales d'Agriculture Canada, tout en répondant aux besoins de la Région ou aux secteurs de pointe particuliers au Québec.

La station de recherches de Sainte-Foy, située à proximité de la Faculté d'agriculture de l'Université Laval, oriente sa recherche principalement sur les sols, les céréales et les fourrages. Des équipes de recherches font un travail en profondeur sur la résistance des plantes au froid ainsi que sur les micro-organismes tels que les rhizobiums et les mycorhizes qui vivent en étroite association avec les plantes. Ces travaux obligent nos chercheurs à travailler dans le domaine de la biotechnologie et de la conservation de l'énergie. L'administration des fermes expérimentales de Normandin et de La Pocatière ainsi que de la sous-station expérimentale Jean-Charles Chapais relève de cette station. Ces établissements travaillent en étroite collaboration avec la station de recherches dans la sélection de nouveaux cultivars de céréales et de plantes fourragères. La ferme expérimentale de La Pocatière, en plus de participer au programme de génétique et de nutrition des moutons, évalue la rusticité et la productivité des espèces et des cultivars de céréales et de plantes fourragères dans les conditions du Bas Saint-Laurent. Ses travaux s'étendent également à la pomme de terre, à la malherbologie et à la protection des cultures en général. La ferme expérimentale de Normandin, en plus de participer au projet national de génétique des bovins laitiers, évalue la rusticité et la productivité des espèces et des cultivars de céréales et de plantes fourragères dans les conditions du Lac Saint-Jean. Ses travaux s'étendent également au bleuet, à la gourgane horticole, aux fines herbes pour ne nommer que quelques-uns de ses projets.

La station de Saint-Jean fait des recherches sur les cultures horticoles et les grandes cultures. Ses travaux portent sur la production et la protection de ces cultures et, tout principalement, sur des fruits comme la pomme, le bleuet, la fraise, la framboise, la poire et la prune, sur des légumes comme le chou et les membres de cette famille, la carotte, l'oignon, le maïs, la laitue, le céleri et l'ail. Des travaux viennent de commencer dans le domaine des fines herbes, des huiles essentielles et des plantes médicinales. Un nouvel édifice de bureaux et de laboratoires est en construction présentement et devra fournir aux chercheurs de meilleures conditions de travail en 1984. La ferme expérimentale de l'Assomption, qui avec sa sous-station expérimentale de Lavaltrie étudie les tabacs à cigare et à cigarette, a un programme de recherches sur les arbres et les arbustes d'ornementation et collabore avec la station de Saint-Jean à la création de lignées de maïs-grain résistant aux insectes et aux maladies. Les sous-stations expérimentales de Frelighsburg, Sainte-Clothilde, et L'Acadie sont les champs expérimentaux de la station pour ses travaux dans les domaines respectifs des fruits, du maraîchage et des productions légumières.

La station de Lennoxville oriente ses travaux sur les productions animales, en particulier le troupeau laitier, le bovin de boucherie, le porc et le mouton. On a engagé quelques nouveaux chercheurs durant l'année et quelques-uns bénéficient de congés d'études dans le but de compléter leurs connaissances ce qui leur permettra de s'orienter dans les domaines prioritaires. Cette station s'intéresse aussi à la production de fourrages pour les ruminants et à des façons d'utiliser le fumier qui permettraient de réduire les risques de pollution de l'environnement. Les fermes de Normandin et de La Pocatière assument une partie du programme laitier et du programme sur le mouton. La station planifie un nouveau complexe de bureaux et de laboratoires qui permettront aux chercheurs de travailler dans de meilleures conditions physiques et de donner leur plein rendement.

Le Centre de recherches alimentaires qui sera construit dans le Parc industriel de Saint-Hyacinthe en est au stade de la planification. On a engagé le directeur et quelques chercheurs. Ces employés travaillent présentement dans des locaux fournis par les Universités Laval et McGill ou par l'Université du Québec. La construction du Centre ne sera pas terminée avant 1986, mais entre-temps certains travaux de recherches se feront dans les laboratoires universitaires mentionnés plus haut.

Les programmes réalisés à nos diverses stations sont intégrés aux programmes à contrat qui complètent les travaux de recherches de la Région. La recherche à contrat permet à l'industrie agricole et para-agricole de s'engager dans le secteur de la recherche et du développement, et de prendre en mains la solution de leurs problèmes technologiques.

On peut obtenir de plus amples renseignements sur les programmes en écrivant à ces établissements ou en communiquant avec le siège de la Région du Québec, Direction générale de la recherche, Agriculture Canada, Complexe Guy Favreau—Tour Est, 200 boulevard Dorchester ouest—Suite 1002, Montréal (Québec) H2Z 1Y3.

J.-J. Jasmin

PREFACE

The Quebec Region, which previously consisted of three research stations, three experimental farms, and five experimental substations, was expanded in 1983 to include the Food Research Centre in Saint-Hyacinthe. The development and construction of this new facility, which will take a few years to complete, will give a major boost to agriculture and food research in the Region. The Region's budget and staff kept pace with inflation, thus remaining at their levels of previous years. The Region's research programs are designed to meet the Department's national priorities but are also adapted to serve the needs of Quebec's key sectors.

The Sainte-Foy Research Station, located near the Faculty of Agriculture of Laval University, is mainly concerned with soils, cereals, and forage crops. Research teams carry out intensive studies on the cold hardiness of plants and on microorganisms, such as rhizobia and mycorrhizae, that live in close association with plants. This work requires our scientists to focus on biotechnology and energy conservation. The Station administers two experimental farms, Normandin and La Pocatière, and an experimental substation, Jean-Charles Chapais, which work closely with the Research Station in selecting new cereal and forage cultivars. Besides taking part in the sheep breeding and nutrition programs, La Pocatière Experimental Farm evaluates various cultivars of cereals and forages under the conditions of the Lower Saint Lawrence region. The Farm also deals with potatoes, weeds, and crop protection. As well as its work in the national dairy cattle breeding program, the Normandin Experimental Farm evaluates various cultivars of cereals and forages under the conditions of the Lac Saint-Jean region. The Farm also studies blueberries, broad beans, and herbs.

The Saint-Jean Research Station is concerned with the production and protection of horticultural and field crops. Apples, blueberries, strawberries, raspberries, pears, and plums are the chief fruits grown at the Station. The main vegetables studied are cabbages and other crucifers, carrots, onions, corn, lettuce, celery, and garlic. The Station has also just started work on herbs, essential oils, and medicinal plants. A new office and laboratory complex, now under construction, should provide scientists with better working conditions in 1984. L'Assomption Experimental Farm, together with its Lavaltrie experimental substation, studies cigar and cigarette tobaccos. The farm also runs a research program on ornamental trees and shrubs and cooperates with the Saint-Jean Station in developing strains of grain corn resistant to insects and disease. The experimental substations at Frelighsburg, Sainte-Clothilde, and L'Acadie provide the Saint-Jean Station with facilities for field work on fruits, vegetables, and market-garden crops.

The Lennoxville Station works chiefly with livestock, primarily dairy cattle, beef cattle, sheep, and swine. A few new scientists were hired during the year, and others were granted educational leave to further their knowledge and prepare for work in priority areas. The Station also studies production of forage for ruminants, as well as ways of using manure that result in less environmental pollution. The Normandin and La Pocatière farms support the Station's dairy program and sheep program, respectively. The Station is planning a new office and laboratory complex that will provide scientists with optimum working conditions.

The Saint-Hyacinthe Food Research Centre, to be located in the city's industrial park, is in the planning stage. A few scientists and a director have been recruited. This staff is now working in premises provided by Laval University, McGill University, and the University of Quebec. Construction of the Centre will not be completed until 1986, but in the meantime some research will be done in the laboratories of the above-mentioned universities.

The research programs carried out at our various establishments are integrated with related contract research programs. The contracting of research enables agricultural industries to become involved in research and development and to work out solutions to their technological problems.

Further information on programs can be obtained by writing to the establishments concerned or by contacting Quebec Region Headquarters, Research Branch, Agriculture Canada, Guy Favreau Complex—East Tower, 200 Dorchester Boulevard West, Suite 1002, Montreal, Quebec H2Z 1Y3.

J.-J. Jasmin

Centre de recherches alimentaires
Saint-Hyacinthe, Québec

CADRES PROFESSIONNELS

R.R. Riel, B.Sc.A., M.Sc., Ph.D.	Directeur

Biotechnologie

F. Cormier[1]	Culture des cellules

Produits laitiers

D. Roy[2] B.Sc. (Vivres)
S. Gauthier[2] B.Sc. (Vivres)

Produits carnés

C.G. Zarkadas B.Sc., M.Sc., Ph.D.	Biochimie musculaire
B.H. Lee B.Sc., M.Sc., Ph.D.	Microbiologie des viandes

Génie alimentaire

C. Toupin[2] B.S c. (Vivres)

---

[1] Recruté en 1983
[2] En congé de formation au doctorat

INTRODUCTION

Les activités scientifiques du Centre de recherches alimentaires ont été limitées aux travaux de deux chercheurs qui travaillent aux universités Laval et McGill. En 1983, les recherches ont porté sur le programme des viandes. Une entente entre Agriculture Canada et l'Université McGill a conduit à l'établissement d'un laboratoire fédéral de recherche en biochimie musculaire au Collège Macdonald. Un troisième chercheur recruté en 1983 poursuit des recherches à l'Institut Armand Frappier dans le domaine de la culture des tissus.

Le Centre de recherches alimentaires est en voie de construction à Saint-Hyacinthe et l'aménagement dans ce Centre est prévu pour 1986.

R.R. Riel
Directeur

VIANDES

Le procédé analytique pour la détermination des acides aminés basiques dans les viandes a été écourtée de 40% et les degrés de sensitivité et de résolution ont été augmentés en même temps. Une méthode encore plus rapide, particulièrement sensible et précise a aussi été développée pour des acides aminés particuliers. Ces développements nous orientent sur la voie du contrôle objectif de l'authenticité des viandes par la connaissance et la mesure de la composition des protéines musculaires.

Au plan de la microbiologie des produits carnés, il a été démontré pour des pains de viande que l'emballage sous atmosphère d'azote retarde le développement des levures et des moisissures et aussi le verdissement des viandes emballées. Les températures de stockage supérieures à 0°C ont été trouvées favorables à la croissance des lactobacilles, des psychrotrophes et des anaérobies même pour les emballages sous vide ou sous azote.

PUBLICATIONS

Recherche

Lee, B.H.; Simard, R.E.; Laleye, L.C. et Holley, R.A. 1983. Microflora, Sensory and Exudate Changes of Vacuum- or Nitrogen-Packed Veal Chucks Under Different Storage Conditions. J. Food Sci. 48(5):1537-1542 & 1563.

Simard, R.E.; Lee, B.H.; Laleye, C.L. et Holley, R.A. 1983. Effects of Temperature, Light and Storage Time on the Physicochemical and Sensory Characteristics of Vacuum— or Nitrogen—Packed Frankfurters. J. Food Protection 46(3):188-195.

Simard, R.E.; Lee, B.H.; Laleye, C.L.; Holley, R.A. 1983. Effects of Temperature, Light and Storage Time on the Microflora of Vacuum— or Nitrogen—Packed Frankfurters. J. Food Protection 46(3):199-205.

Lee, B.H.; Simard, R.E.; Laleye, C.L.; Holley, R.A. 1983. Shelf-life of meat loaves packaged in vacuum or nitrogen gas. I. Effect of storage temperature, light and timne on the microflora change. J. Food Protection 47:128-133.

Lee, B.H.; Simard, R.E.; Laleye, C.L. et Holley, R.A. 1983. Shelf-life of meat loaves packaged in vacuum or nitrogen gas. 2. Effect of storage temperature, light and time on physiochemical and sensory changes. J. Food Protection 47:134-139.

Zarkadas, C.G.; Dorsey, A.M.; Kesner, L.; Shin, S.L.; Wadewitz, A.G.; Rushbrooke, J.I.; Stacker, A. 1983. Methylated amino acid content of myosin from normal and dystrophic chickens during development. J. Cell. Biol. 97:462a.

Station de recherches Lennoxville, Québec

CADRES PROFESSIONNELS

Administration

Y. Martel, B.A., B.Sc.(Agr.), Ph.D.	Directeur
J. de Léséleuc	Services administratifs

Soutien scientifique

S. Gagné-Giguère,[1] B.A., M.A., M. Bibl.	Bibliothèque
A. Belleau	Informatique

Production animale

M. H. Fahmy, B.Sc.(Agr.), M.Sc., Ph.D.	Chef d'objectif; génétique—moutons
A.M.B. de Passillé, B.Sc., M.Sc.	Éthologie—porcs
J.J. Dufour, B.Sc.(Agr.), M.Sc., Ph.D.	Physiologie de la reproduction-porcs
P.M. Flipot, B.Sc.(Agr.), M.Sc., Ph.D.	Nutrition—bovins de boucherie
J. Matte,[2] B.Sc.(Agr.), M.Sc.	Nutrition—porcs
J. Bernier,[3] B.Sc.(Agr.), M.Sc.	Régie—boeufs
C. Farmer,[4] B.Sc.(Agr.), M.Sc.	Régie—porcs
S. Pommier,[5] B.Sc., M.Sc.	Qualité des viandes—bovins, porcs, moutons

Production laitière

G.L. Roy, B.S.A., M.Sc., Ph.D.	Chef d'objectif; génétique—bovins
C. Vinet,[6] B.Sc.(Agr.), M.Sc.	Nutrition—bovins laitiers
B. Lachance, B.Sc.(Agr.), M.Sc.	Nutrition—jeunes ruminants
C. Girard,[7] B.Sc.(Agr.), M.Sc.	Nutrition—jeunes ruminants
J. Chiquette,[8] B.Sc.(Agr.), M.Sc.	Microbiologie du rumen
L. Guilbault, B.Sc., M.Sc.	Physiologie de la reproduction—bovins
G. Pelletier, B.Sc.(Agr.), M.Sc., Ph.D.	Physiologie de la digestion—bovins

D. Petitclerc, B.Sc., B.Sc.(Agr.), M.Sc., Ph.D.	Physiologie de la lactation—bovins
N. St-Pierre,[9] B.Sc.(Agr.), M.Sc.	Analyse de systèmes

Production fourragère et sols

J.-L. Dionne, B.A., B.Sc.(Agr.), Ph.D.	Chef d'objectif; fertilité des sols
G.M. Barnett, B.Sc.(Agr.), M.Sc.	Régie et environnement
W. Mason, B.Sc.(Agr.), M.Sc., Ph.D.	Régie et qualité des plantes fourragères
R. Simard,[10] B.Sc.(Agr.), M.Sc.	Fertilité des sols
A.R. Pesant, B.Sc.(Agr.), M.Sc.	Physique des sols
C. Fernet, B.Sc.	Amélioration des plantes

---

[1] Détachée de la Direction générale des affaires financières et administratives, Division des bibliothèques.
[2] En congé d'études de Ph.D., Université Laval, mai 1981—.
[3] En congé d'études de Ph.D., Université Davis, juin 1983—.
[4] En congé d'études de Ph.D., Université de la Pennsylvanie, septembre 1981—.
[5] En congé d'études de Ph.D., Université du Wisconsin, juin 1980—.
[6] En congé d'études de Ph.D., Université de l'Ohio, août 1981—.
[7] En congé d'études de Ph.D., Université Laval, mai 1981—.
[8] En congé d'études de Ph.D., Université de l'Alberta, mai 1982—.
[9] En congé d'études de Ph.D., Université de l'Ohio, août 1981—.
[10] En congé d'études de Ph.D., Université de Guelph, juin 1983—.

INTRODUCTION

La station de recherches de Lennoxville et sa ferme expérimentale visent à solutionner les problèmes importants au Québec dans les domaines des productions animales, des plantes fourragères et des sols. Les programmes de recherches sont placés sous trois objectifs: la production de viande incluant les travaux sur les bovins de boucherie, les porcs et les ovins, la production laitière ainsi que la production fourragère et les sols.

En septembre 1983, Denis Petitclerc a complété ses études de Ph.D. à l'Université du Michigan et est revenu à temps complet à Lennoxville pour entreprendre des recherches sur la physiologie de la lactation des bovins laitiers.

On peut obtenir des renseignements plus complets en écrivant directement aux chercheurs à l'adresse suivante: Station de recherches, Agriculture Canada, C.P. 90, Lennoxville, Québec, J1M 1Z3.

Yvon Martel
Directeur

PRODUCTION ANIMALE

Bovins laitiers

De faibles quantités de foin servi à des veaux nourris de grain et abattus au poids vif de 180 kg. Les rations de concentrés utilisées dans la production de veaux de grain sont généralement très peu élevées en fibres brutes ou fibres ADF. Une étude a été réalisée avec 66 veaux mâles laitiers, de type Holstein, afin de déterminer les performances des veaux recevant 3 rations qui contiennent de faibles niveaux de fibres ADF: R_1—veaux recevant du concentré *ad libitum*, R_2—veaux recevant du concentré *ad libitum* et un maximum de 7,5% de foin, R_3—veaux recevant du concentré *ad libitum* et un maximum de 15% de foin. Tous les veaux ont reçu un aliment d'allaitement (20,1% de protéines brutes et 19,8% de gras), deux fois par jour, pour une période minimale de 4 semaines. Le concentré (87% de matière sèche, 16% de protéines brutes, 6,8% de fibres ADF) et le foin de graminées (87,5% de matière sèche, 7,7% de protéines brutes, 36,7% de fibres ADF) furent introduits au cours de la première semaine. La quantité de foin haché à servir était calculée trois fois par semaine en se fondant sur la quantité de concentré consommé au cours des jours précédents. Un essai de digestibilité a été réalisé au cours des septième, douzième et dix-huitième semaines.

On n'a pas observé de différence significative ($P < 0,05$) de poids au cours de l'expérience pour les trois régimes (R_1, R_2, R_3). À 6 semaines, les poids étaient respectivement de 57, 56 et 56 kg, à 12 semaines, de 95,6, 98,4 et 96,0 kg et, à 18 semaines, de 145,2, 149,6 et 145,4; le gain quotidien se chiffrait ainsi à 0,83, 0,85, et 0,83 kg. Au cours de la période de pré-sevrage, soit durant les 6 premières semaines, il a été possible de faire consommer les quantités de foin prévues en proportion des quantités de concentré consommé, soit 6,9% pour le groupe R_2 et 14% pour le groupe R_3. Par la suite, la consommation de foin par rapport à la consommation de concentré a été en moyenne de 5,0% pour le groupe R_2 et 6,2% pour le groupe R_3, bien que 7,5% et 15% de foin étaient offerts. La consommation totale de foin par veau a été de 22,2 kg pour le groupe R_2 et 26,3 kg pour le groupe R_3. La consommation totale de concentré par veau a été respectivement de 441,8, 425,7 et 412,7 kg pour les régimes R_1, R_2 et R_3. Les quantités consommées étaient significativement différentes ($P < 0,05$). Cependant, la consommation totale d'aliments par veau a été pratiquement identique (461,1, 467,4 et 458,2 kg) et de même pour l'efficacité alimentaire, soit 3,47, 3,54 et 3,50 kg d'aliments/kg de gain. Au cours de la septième semaine, l'apport de foin n'a pas influencé significativement ($P < 0,05$) la digestibilité apparente de la matière sèche (77,9, 74,3 et 76,2%), des protéines brutes (72,7, 71,5 et 73,7%), de l'énergie (74,1, 70,0 et 72,7%) et de l'amidon (89,8, 87,1 et 88,5%). Il y a eu cependant une baisse significative ($P < 0,05$) au niveau des fibres ADF (63,2, 56,2 et 58,5%). Au cours de la douzième semaine, la digestibilité apparente de la matière sèche (80,1, 76,5 et 78,2%), des protéines brutes (75,9, 73,5 et 75,4%), de l'énergie (79,6, 75,9 et 77,1%) et de l'amidon

(92,2, 89,6 et 90,7%) a été légèrement supérieure à celle observée durant la sixième semaine, mais le niveau de foin consommé n'a pas eu d'influence ($P < 0,05$) tandis que cela a été le cas pour les fibres ADF (62,0, 54,9 et 55,1%). Au cours de la dix-huitième semaine, la digestibilité apparente est demeurée sensiblement la même qu'au cours de la douzième semaine. Le rendement des carcasses à l'abattage était identique d'un régime à l'autre (53,7, 53,3 et 53,9%). L'apport de foin n'a pas eu d'influence sur l'hématocrite (33,7, 38,5 et 37,6%) et le niveau d'hémoglobine (12,0, 11,8 et 11,8 g/100 mL) au moment de l'abattage. L'indice de coloration du muscle au niveau de la 12^{e} côte était semblable ainsi que le classement des carcasses.

Les effets des glucocortïcoides sur le pancréas et la croissance de jeunes veaux. Il est préférable de réduire la période pendant laquelle le veau a besoin d'une alimentation de lait ou de succédané de lait. Le développement du système digestif est influencé par certaines hormones. L'acétate d'hydrocortisone ou le dexaméthasone a été injecté à des veaux de 3 ou 17 jours d'âge dans le but de mesurer leurs effets sur le pancréas. L'hydrocortisone injecté à 3 jours augmentait dans le pancréas l'activité de l'amylase et de la chymotrypsine, le contenu en protéines, l'ADN et l'ARN. Toutefois, les glucocorticoïdes injectés à des veaux de 21 jours d'âge n'ont eu aucun effet sur l'activité des enzymes digestives. Chez le veau de 3 jours, le pancréas s'est hypertrophié à la suite du traitement hormonale tandis que chez le veau de 21 jours l'effet a été identifié comme étant une augmentation du nombre de cellules et non une hypertrophie. La réponse au traitement chez le très jeune veau est interprétée comme étant une accélération du développement normal du tissu cible. L'injection de cortisone à des veaux de 3 jours d'âge n'a pas eu d'effet sur la consommation mais la croissance a accusé un léger retard durant les 2^{e} et 3^{e} semaines d'âge.

Porcs

Facteurs influençant les changements anatomiques et biochimiques du tube digestif de la truie au cours d'un cycle de reproduction. Le but de cette étude était de déterminer l'influence de la gestation, de la lactation, de la taille de la portée et de la densité énergétique de la ration sur les changements anatomiques et biochimiques du tube digestif de la truie. Dans une première expérience nous avons utilisé 50 truies qui recevaient une moulée de composition semblable selon un programme alimentaire traditionnel. Les truies ont été abattues à 110 jours de gestation ou à 21 jours de lactation et les organes du tube digestif ont été prélevés. Des groupes témoins de truies non gestantes ont été comparés à un groupe de truies à 110 jours de gestation ou à des truies allaitant huit ou 12 porcelets.

Une deuxième expérience a été réalisée avec 36 truies Landrace et trois autres traitements. Un groupe témoin de truies non gestantes et un groupe de truies lactantes ont été alimentées avec une moulée à bas niveau d'énergie digestible (3163 kcal/kg), et un troisième groupe de truies lactantes ont été alimentées avec une moulée à haut niveau d'énergie digestible (3775 kcal/kg) durant la lactation ou durant une période équivalente aux groupes témoins.

La gestation n'a pas eu d'effet sur le poids des organes prélevés tandis que la lactation a été responsable d'une augmentation du poids de l'estomac, du petit et du gros intestin chez les truies de seconde parité. Cependant, seulement l'estomac des truies de quatrième parité a augmenté au cours de la lactation. La taille de la portée (8 vs 12 porcelets) a influencé la longueur du petit intestin ainsi que le poids et la longueur du gros intestin. Les poids de l'estomac et du pancréas n'ont pas été influencés par la taille de la portée. Par ailleurs, la moulée à plus haute densité énergétique a produit des augmentations du poids du pancréas et du petit intestin de l'ordre de 13 et 20% respectivement, et une augmentation de 11% de la longueur du petit intestin. Les niveaux d'enzymes digestives du pancréas et de l'estomac ont aussi changé au cours de la gestation et de la lactation.

Les augmentations de poids du pancréas et du petit intestin au cours de la lactation pourraient avoir des effets bénéfiques sur la performance des truies, particulièrement chez celles qui ont allaité un nombre élevé de porcelets.

L'effet du carbadox sur la reproduction des porcs qui en reçoivent jusqu'à ce qu'ils aient atteint le poids de 60 kg. Cette expérience visait à déterminer l'effet du carbadox sur la performance reproductrice des porcs dont la moulée en contenait 55 mg/kg, à compter d'une semaine après leur naissance et jusqu'à ce qu'ils aient atteint le poids d'environ 60 kg.

On a utilisé à cette fin cinq portées dont chacune comptait quatre soeurs propres et quatre soeurs adoptives; cinq couples de mâles, issus d'autant de portées, ont servi aussi à réaliser cette expérience. La moitié des soeurs et des mâles ont reçu la moulée médicamenteuse, tandis que les autres constituaient les témoins. On a accouplé chacun des mâles à deux soeurs expérimentales et à deux soeurs témoins. Les observations de l'expérience portaient sur les paramètres suivants: la longueur du cycle oestral; l'intervalle entre le sevrage et l'oestrus ultérieur; le taux de conception; l'âge et le poids des truies à leur premier oestrus, au moment de l'accouplement, après 109 jours de gestation, ainsi qu'au moment de la parturition et immédiatement après; la durée de la gestation; le nombre de porcelets de chacune des portées et leur poids, à la naissance et à l'âge de 28 jours. Les résultats de cette expérience ont révélé que le carbadox n'exerçait aucune influence apparente sur la performance reproductrice.

Effet, sur quelques paramètres sanguins, de l'addition de tourteau de canola à la ration des truies. Des échantillons de sang ont été prélevés dans la veine caudale de 22 truies ne recevant pas de tourteau de canola et de 26 truies recevant 10% de tourteau de canola dans leur ration. Les prélèvements sanguins ont été effectués à trois états physiologiques de la reproduction porcine: au 110^e jour de gestation, au sevrage et au troisième jour du cycle oestral ultérieur au sevrage. Toutes les truies avaient libre accès à l'eau et recevaient chacune en moyenne 2,74 kg d'aliments par jour en un seul repas durant la gestation. Durant la lactation, les quantités d'aliments étaient ajustées selon le nombre de porcelets jusqu'à un maximum de 4,5 kg/jour.

L'addition de canola à la ration n'a pas influencé les paramètres sanguins étudiés (calcium, phosphore, magnésium, sodium, potassium, protéines totales et l'azote uréique), et ce, pour les trois différents états physiologiques. Cependant, certains de ces paramètres ont varié d'une façon significative, d'un état physiologique à un autre, chez une même truie. Le phosphore, le sodium, le potassium, les protéines totales et l'azote uréique étaient significativement plus concentrés au troisième jour du cycle oestral ultérieur au sevrage qu'au 110^e jour de gestation.

À partir de nos résultats, on peut conclure que le tourteau de canola et le nombre de porcelets à la parturition n'ont pas influencé les paramètres sanguins étudiés.

Les relations entre le comportement néonatal des porcelets, leur taux d'immunoglobuline sanguin à 12 h d'âge, leur survie et leur croissance. L'ordre de naissance, l'intervalle entre les naissances, l'intervalle entre la naissance et la première tétée et le taux d'Ig à 12 h d'âge de la portée ont été mesurés sur 274 porcelets de 23 portées. Les observations de comportement ont été faites sur 211 porcelets provenant de 18 portées. Ces observations comprenaient le nombre de tétées bues, le nombre et la durée des batailles ainsi que le pourcentage de batailles gagnées durant les huit premières heures de vie. Les échantillons de sang ont été pris dans la veine cave antérieure et les Ig dosées dans le sérum par la méthode d'immunodiffusion radiale.

Les porcelets ont été divisés en trois groupes: un groupe mortalité (porcelets morts avant le sevrage à 21 jours d'âge), un groupe de croissance lente (porcelets n'ayant pas doublé de poids avant 10 jours d'âge) et un groupe de bonne croissance (porcelets ayant doublé de poids à 10 jours d'âge).

Ces porcelets pesaient en moyenne 1,4 kg à la naissance quel que soit le groupe dont ils faisaient partie. Les porcelets du groupe de croissance lente avaient un gain moyen à 10 jours d'âge significativement plus faible que celui des porcelets de croissance rapide et cette différence de gain demeurait significative à 21 jours d'âge. Dès 12 h d'âge, on observait une perte de poids significativement plus élevée chez les porcelets du groupe mortalité que chez ceux du groupe de croissance lente. Par contre, les porcelets du groupe de croissance rapide démontraient déjà des gains de poids.

On a observé des différences dans la fréquence des tétées et dans les taux d'Ig, mais pas dans la fréquence ou le succès obtenu lors des batailles. Les porcelets du groupe mortalité avaient tété moins fréquemment durant leur huit premières heures de vie et avaient un taux d'Ig sanguin plus faible à 12 h d'âge que les porcelets survivants. Les porcelets du groupe de croissance lente avaient un taux d'Ig sanguin plus faible et accusaient une perte de poids à 12 h d'âge en comparaison avec les porcelets du groupe de croissance rapide, quoiqu'ils aient tété aussi souvent.

Moutons

Concentration de LH en période prépubertaire, taux d'ovulation, taille et prolificité des brebis de race Finn, Suffolk et du croisement Finn X Suffolk. Cinquante-sept agnelles de race Finn, Suffolk et Finn X Suffolk ont été utilisées comme sujets d'expérience. Celle-ci visait essentiellement à établir, chez les différents types génétiques, une relation entre le niveau LH prépubertaire, mesuré à intervalles réguliers entre l'âge de deux et dix semaines et le taux d'ovulation de même que la grosseur de la portée des futures mères. Le taux d'ovulation et la taille de la portée ont été respectivement de 2,7 et de 1,9 pour la race Finn, de 1,2 et 1,1 pour la race Suffolk et de 1,8 et 1,6 pour le croisement Finn X Suffolk lorsque les agnelles étaient accouplées à l'oestrus suivant la puberté. Le groupe de brebis le plus prolifique (Finn) n'enregistrait pas toujours le plus haut indice de LH par rapport aux autres groupes à l'étude. Ceci nous porte à croire que la relation entre le niveau de LH et la prolificité des races est plus étroitement liée à l'âge des brebis. Par ailleurs, à l'intérieur de chaque groupe génétique, le niveau moyen de LH était généralement plus élevé chez les brebis considérées comme les plus prolifiques: de petites différences ont été observées jusqu'à l'âge de 6 semaines. Ces résultats démontrent qu'en bas âge, le taux de LH n'est pas un indicateur sûr de la performance reproductrice de la brebis.

Changements saisonniers dans l'accouplement, la grosseur des testicules, la concentration de testostérone et les caractéristiques du sperme des béliers pendant la saison d'accouplement que celle-ci soit longue ou courte. L'activité sexuelle (libido), la grosseur des testicules, les niveaux de testostérone et les caractéristiques du sperme ont fait l'objet de comparaison entre 10 béliers adultes DLS (moitié Dorset, quart Leicester, quart Suffolk), sélectionnés en raison d'une saison d'accouplement prolongée, et 10 autres de race Suffolk. L'étude s'est poursuivie pendant 18 mois, au cours desquels les données pertinentes ont été recueillies plus de 30 fois.

Tous les paramètres mentionnés plus haut ont varié de façon significative selon la saison; la variation la plus marquée étant à l'automne et la moins importante à l'été. Les béliers Suffolk ont démontré une libido plus élevée que les béliers DLS; par contre, le niveau de testostérone des premiers était inférieur. Il ressort aussi de cette étude que le niveau de testostérone augmentait plus tôt et décroissait plus tard dans la saison d'accouplement chez les béliers DLS comparativement aux béliers Suffolk. La concentration de testostérone semble étroitement liée au diamètre des testicules et à la libido si on se réfère aux variations obtenues: 65% et 28% chez les Suffolk et 37% et 18% chez les béliers DLS. Le summum du rendement et de la qualité du sperme (motilité et pourcentage de mobilité) était en octobre et novembre; le plus bas degré a été atteint en avril et mai.

Selon les races, les béliers se sont montrés différents du point de vue de l'étude des caractéristiques du sperme. Par surcroît, l'étude a démontré que la sélection de brebis DLS à saison d'accouplement prolongée peut, selon toute vraisemblance, avoir influé sur les performances de reproduction des béliers de la même race.

Performances des brebis DLS et des brebis croisées Finn X DLS. Des brebis DLS ont été accouplées avec des béliers finnois et les brebis moitié finnoises obtenues de ce croisement ont été accouplées avec des béliers finnois et DLS pour produire les deux croisements de retour (quart F et trois-quarts F). Les brebis DLS, quart F, moitié F et trois quarts F ont été accouplées avec des béliers DLS, quart F, moitié F et F purs de 1976 à 1981. L'accouplement *inter se* n'était pas permis. Les caractères étudiés étaient le pourcentage de brebis ayant agnelé, le nombre d'agneaux nés au total, nés vivants et sevrés par brebis ayant agnelé, la production en kilogramme d'agneaux nés et sevrés, et la date d'agnelage suivant l'accouplement en juin. Le pourcentage de brebis ayant agnelé dans les quatre groupes génétiques était au-dessus de 96%. Le nombre d'agneaux nés par portée a augmenté de façon presque linéaire avec l'augmentation de la proportion de finnois; il était de 1,17, 1,37, 1,75 et 1,92 pour les DLS, quart F, moitié F et trois quarts F respectivement. Le taux de mortalité à la naissance a été le plus élevé dans le groupe trois quarts F (12,0%) et le plus bas dans le groupe quart F (3,6%). Le taux de mortalité avant sevrage était aussi plus élevé dans le groupe trois quarts F (17,0%) suivi du groupe moitié F (8,0%). Le nombre d'agneaux sevrés était de 1,09, 1,29, 1,61 et 1,64 dans les quatre groupes respectivement. Le poids de la portée à la naissance variait entre 5,07 kg pour le DLS et 5,54 kg pour les moitié F. Le poids de la portée au sevrage était de 27,0 kg pour les DLS. Le poids des trois autres croisements était de 3 kg de plus. Les brebis agnelaient plus tardivement avec l'augmentation de la proportion de finnois dans les croisements: du 22 décembre, en moyenne, pour les DLS au 30 janvier, en moyenne pour les trois quarts F.

Le développement de la race ovine DLS: premier stage de développement. Les gènes des races Dorset, Leicester et Suffolk ont été mis en commun pour créer une nouvelle race de moutons appelée DLS. Des béliers Dorset (D) ont été accouplés à des brebis Leicester (L) et Suffolk (S) pour donner des croisements DL et DS à leur tour croisés pour former la première génération de DLS. Les données recueillies entre 1967 et 1971, inclusivement, portent sur 2185 portées et 3070 agneaux. Nous avons noté les caractères suivants: grosseur de la portée, poids à la naissance et accroissement de poids journalier moyen des agneaux à la naissance, avant le sevrage et au sevrage. La taille moyenne des portées des brebis DL était de 1,52 agneaux, 7,8% de plus que celle des brebis DS. Les brebis DL et DS avaient des portées dont la grosseur moyenne était supérieure de 9,8% et 4,7% ($P< 0,05$) à la moyenne des deux races parentales respectives D (1,33) et L (1,43); D (1,33) et S (1,35). Les portées des brebis DLS produites à partir de mères DL ou DS étaient de grosseur analogue (1,34 et 1,39 respectivement) et étaient inférieures de 6,8% à celles des deux premiers croisements. Le poids moyen à la naissance était de 6,3 kg pour les Suffolk, soit beaucoup plus que pour les Dorset (4,2 kg) et les Leicester (5,7 kg). Le poids moyen à la naissance était de 5,9 kg pour les DL, soit 19,5% ($P< 0,01$) de plus que la moyenne des races D et L. Dans le cas des DS (5,6 kg), le poids était intermédiaire entre celui des races D et S. On a observé des différences significatives du poids à la naissance entre les DL et les DS et entre les DLS et la moyenne des deux premiers croisements. Les agneaux croisés DL, DS et DLS étaient nettement plus lourds à la naissance et au sevrage que les agneaux D. Les résultats indiquent qu'une partie des performances supérieures obtenues dans les premiers croisements de races pures sont perdues lorsque ces premiers croisements sont à leur tour croisés pour obtenir le DLS.

PRODUCTION FOURRAGÈRE ET SOLS

Les graminées changent leur rythme de croissance et leur qualité au cours de la saison de croissance. Au cours de trois saisons, on a observé la croissance des graminées et leur changement de qualité. Des parcelles de fléole, de fétuque élevée, d'alpiste roseau et de pâturin du Kentucky ont été récoltées hebdomadairement, du stade végétatif à celui de pleine maturité, pendant une période de 3 ans afin de déterminer l'effet des récoltes et des espèces sur la production des éléments. Le fourrage du régime hâtif a été coupé après 5 semaines de regain et toutes les parcelles ont été coupées à l'automne.

Une croissance rapide a été signalée de la mi-juin au début de juillet grâce à une vigoureuse pousse initiale, une élongation rapide de la tige, une épiaison et une floraison hâtives. Les différentes espèces ont atteint leur maturité avec 1 ou 2 semaines de différence. La croissance la plus rapide mais aussi le déclin de qualité le plus subit sont survenus à la période de l'épiaison. La digestibilité *in vitro* (DIV) a varié de 80 à 45% avec une diminution durant le mois de juin de 0,74, 0,84, 0,85 et 0,45%/jour pour la fléole, la fétuque élevée, l'alpiste roseau et le pâturin Kentucky, respectivement. Les protéines brutes (PB) de la première coupe ont également varié de 28 à 6% avec une diminution respective de 0,47, 0,40, 0,39 et 0,28%/jour en juin. Le fourrage, provenant du regain de la mi-été et de l'automne, avait une moyenne de 63 et 59% en DIV et de 16 à 20% de PB respectivement. À l'exception de l'alpiste roseau, un retard de la date de la première coupe a donné une augmentation continuelle de rendement total en matière sèche (MS), ainsi qu'une augmentation significative en rendement total de DIV, jusqu'à l'épiaison, et une diminution du rendement total de PB à partir du stade d'élongation. L'alpiste a atteint son niveau maximum de PB au début de l'épiaison, mais son rendement a augmenté de façon significative jusqu'au stade de floraison. Chez toutes les espèces, la récolte au stade d'élongation a réduit substantiellement le rendement en MS, DIV et PB. Malgré que la majorité du rendement en MS ait été obtenu à la première coupe, presque la moitié du rendement total en PB provenait de la coupe finale. Comme la teneur en protéines brutes constitue le facteur limitant la valeur des graminées en vue de la production laitière, on devrait prêter plus d'attention à la conservation du fourrage produit à la deuxième coupe. La haute production de protéines et de matière digestible du pâturin du Kentucky en fait une espèce supérieure au mil comme plante à pâturage, surtout en fin d'été.

PUBLICATIONS

Recherche

Batra, T.R.; McAllister, A.J.; Chesnais, J.P.; Darisse, J.P.F.; Emsley, J.A.B.; Lee, A.J.; Roy, G.L.; Vesely, J.A.; Winter, K.A. 1983. Comparison of the heifer reproduction traits of the daughters of several sire groups. Can. J. Anim. Sci. 63: 269-278.

Batra, T.R.; McAllister, A.J.; Lee, A.J.; Lin, C.Y.; Roy, G.L.; Vesely, J.A.; Wauthy, J.; Winter, K.A. 1983. Body weights and dimensions of pureline and crossline heifers of the Canadian Dairy Cattle Breeding Project. Can. J. Anim. Sci. 63: 511-522.

Christison, G.I.; Farmer, C. 1983. Physical characteristics of perforated floors for young pigs. Can. Agric. Eng. 25: 75-80.

Farmer, C.; Christison, G.I. 1982. Selection of perforated floors by newborn and weanling pigs. Can. J. Anim. Sci. 62: 1229-1336.

Flipot, P.; Tremblay, A.Y.; Dufour, J.J. 1983. Effet, sur quelques paramètres sanguins, de l'addition de tourteau de canola CV. Tower à la ration des truies. Can. Vet. J. 24: 278-280.

Groves, B.I.; Flipot, P.M.; Hartsock, T.G.; Vlielander, L.C. 1983. The effect of carbadox on reproduction when fed to swine up to 60 kilograms body weight. Can. Vet. J. 24: 154-157.

Lin, C.Y.; Batra, T.R.; McAllister, A.J.; Darisse, J.P.F.; Lee, A.J.; Roy, G.L.; Vesely, J.A.; Winter, K.A. 1983. Differences between sire groups in body measurements and body weight changes of lactating cows. Can. J. Anim. Sci. 63: 27-37.

Mason, W.; Lachance, L. 1983. Effects of initial harvest date on dry matter yield, in vitro dry matter digestibility and protein in timothy, tall fescue, reed canarygrass and Kentucky bluegrass. Can. J. Plant Sci. 63: 675-685.

Matte, J.J.; Girard, C.L.; Seoane, J.R.; Brisson, G.J. 1982. Absorption of colostral immunoglobulin G in the newborn dairy calf. J. Dairy Sci. 65: 1765-1770.

Pelletier, G.; Charbonneau, P.; Morisset, J. 1983. Anatomical and biochemical changes of the stomach and duodenum during a reproductive cycle of first-litter sows. Can. J. Anim. Sci. 63: 59-65.

Pelletier, G.; Dunnigan, J. 1983. Effects of administration of glucocorticoids on pancreas and growth of dairy calves. J. Dairy Sci. 66: 1329-1336.

Pelletier, G.; Lano, J.; Filion, M.; Dunnigan, J. 1983. Effect of age and glucocorticoid administration on the proteolytic activity of gastric mucosa: a comparative study in the young rat, calf and piglet. J. Anim. Sci. 57: 74-81.

Petitclerc, D.; Chapin, L.T.; Emery, R.S.; Tucker, H. A. 1983. Body growth, growth hormone, prolactin and puberty response to photoperiod and plane of nutrition in Holstein heifers. J. Anim. Sci. 57: 892-898.

Petitclerc, D.; Chapin, L.T.; Harkins, P.A.; Tucker, H. Allen. 1983. Evidence for photosensitive regulation of prolactin secretion in prepubertal bulls. Proc. Soc. Exp. Biol. Med. 172: 478-481.

Petitclerc, D.; Peters, R.R.; Chapin, L.T.; Oxender, W.D.; Refsal, K.R.; Braun, R.K.; Tucker, H. Allen. 1983. Effect of blinding and pinealectomy on photoperiod and seasonal variations in secretion of prolactin in cattle. Proc. Soc. Exp. Biol. Med. 174: 205-211.

St-Pierre, N.R.; Bouchard, R.; St-Laurent, G.J.; Vinet, C.; Roy, G.L. 1983. Effects of stage of maturity and frost on nutritive value of corn silage for lactating dairy cows. J. Dairy Sci. 66: 1466-1473.

Vesely, J.A.; McAllister, A.J.; Lee, A.J.; Batra, T.R.; Darisse, J.F.P.; Roy, G.L.; Winter, K.A. 1983. Evaluation of cow reproduction in the pureline foundation phase of the Canadian National Dairy Cattle Breeding Project. J. Dairy Sci. 66: 867-873.

Divers

Barnett, G.M.; Comeau, J.E. 1983. Seeding cereals early from the air. Ensemencement précoce des céréales par air. Can. Agric. 29(1): 32-35.

Barnett, G.M.; Dionne, J.-L., eds. [1983]. Soil acidity, liming, and plant growth: translation of a symposium report published in Sols, Agdex 534, MAPAQ. Expert Committee on Soil and Water Management. 100 pp.

Barnett, G.M.; Rioux, R.; Comeau, J.E. 1983. Les céréales et la préparation du sol. Agriculture Canada, Direction générale de la recherche, Contribution 1982-5F. 45 pp.

B. de Passillé, A.M. 1982. Rapport de mission en France dans le cadre du programme d'échange de scientifiques, octobre 1982. Rapport de mission internationale en science et technologie: échange de chercheurs: Canada/ France. International science and technology mission report: Canada/France: exchange of scientists. Agriculture Canada, Direction générale de la recherche, Service aux programmes de recherche, Pub. no XCH82-6. 10 feuillets.

Dionne, J.-L. [1983]. Soil reaction in relation to plant growth. Pages 33-52 *dans* Barnett, G.M.; Dionne, J.-L., eds. Soil acidity, liming, and plant growth: translation of a symposium report published in Sols, Adgex 534, MAPAQ. Expert Committee on Soil and Water Management. 100 pp.

Fahmy, M.H.; Moride, Y. 1983. Utilization of crossbred sows and boars for better pork production. Pages 17-24 *dans* Internationl Symposium on Swine Production, Tokyo University of Agriculture, August 12-13, 1983. 56 pp. [En japonais].

Fernet, C. 1983. Réaction du pois de grande culture, semé à différentes dates à Lennoxville, (Qc) 1980-82. Agriculture Canada, Canadex 142.22.

Fernet, C.; Dupuis, G. 1983. Culture du pois sec en rangées alternées avec le blé au Québec. Agriculture Canada, Canadex 142/112/24.

Martel, Y., éd. 1982. Faits saillants des travaux de la Station de recherches de Lennoxville (Québec) 1982. Agriculture Canada, Direction générale de la recherche, Station de recherches, Bulletin 5. 61 pp.

Martel, Y., éd. 1983. Faits saillants des travaux de la Station de recherches de Lennoxville 1983. Agriculture Canada, Direction générale de la recherche, Station de recherches, Bulletin 6. 53 pp.

Winter, K.A.; Lachance, B. 1983. Conduite et alimentation des jeunes bovins laitiers. Agriculture Canada, Direction générale des communications, Publication 1432F. 29 pp. [Également disponible en anglais sous le titre: Management and feeding of young dairy animals. Agriculture Canada, Communications Branch, Publication 1432E. 26 pp.]

Station de recherches
Sainte-Foy, Québec

CADRES PROFESSIONNELS

Administration

S.J. Bourget, B.Sc. (Agr.), M.S., Ph.D.	Directeur
C. Gagnon, B.S., B.Sc. (Agr.), M.Sc., Ph.D.	Directeur adjoint
R. Labelle,[2]	Services administratifs
T. Nadeau,	Services administratifs par intérim

Soutien scientifique

P. Venne,[1] B.Bibl., M.L.S.	Bibliothèque

Amélioration des plantes

J.M. Deschênes,[3] B.Sc. (Agr.), M.Sc., Ph.D.	Chef de la section; écologie
R. Michaud, B.Sc. (Agr.), M.Sc., Ph.D.	Chef de la section par intérim; génétique des légumineuses
M. Bernier-Cardou, B.Sc., M.Sc.	Statistiques
M.R. Bullen, B.Sc. (Agr.), M.Sc., Ph.D.	Génétique des plantes fourragères
J.P. Dubuc, B.Sc. (Agr.), Ph.D.	Génétique des céréales
M. Germain, B.Sc. (Agr.)	Physiologie des graminées fourragères
P. Boutet, B.Sc.	Informatique
A. Légère, B.Sc., M.Sc.	Malherbologie
J. Surprenant, B.Sc. (Agr.), M.Sc.	Génétique des graminées fourragères

Physiologie des plantes

R. Paquin, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Chef de la section; survie à l'hiver
R. Bolduc, B.S., B.Sc. (Agr.), Ph.D.	Résistance au froid, cytologie
Y. Castonguay B.Sc. (Agr.), M.Sc.	Agrométéorologie
H.J. Hope, B.Sc., M.Sc., Ph.D.	Résistance au froid, mécanisme
P. Nadeau, B.Sc., D.Sc.	Résistance au froid, mécanisme

Phytoprotection

C. Gagnon, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Chef de la section; maladies des légumineuses
N. Bissonnette, B.Sc. (Agr.), M.Sc.	Microbiologie
L. Bordeleau, B.Sc. (Agr.), M.Sc., Ph.D.	Microbiologie
A. Comeau, B.Sc., Ph.D.	Entomologie
L. Couture, B.A., B.Sc. (Agr.), M.Sc., Ph.D.	Maladies des céréales
V. Furlan, B.Sc., D.Sc.	Endomycorhizes
R. Lalande, B.Sc. (Agr.), M.Sc.	Microbiologie
D. Prévost, B.Sc. (Agr.), M.Sc.	Microbiologie
C. Richard, B.Sc., M.Sc., D.Sc.	Maladies des légumineuses
J. Santerre, B.A., B.Sc., M.Sc.	Nématologie
P. Savoie, B.Sc. (Agr.), M.Sc., Ph.D.	Génie des plantes fourragères

Sols

D. Isfan, B.Sc., Ph.D.	Chef de la section; chimie, fertilité
C. De Kimpe, B.A., Ing. Chim. et Ind. (Agr.),	Génèse D.Sc.
M. Laverdière, B.Sc. (Agr.), M.Sc., Ph.D.	Pédogénèse et minéralogie
J. Zizka, B.A., B.Sc. (Agr.), M.Sc.	Fertilité

Ferme expérimentale, La Pocatière

J.E. Comeau, B.Sc. (Agr.), M.S.	Surintendant
L. Belzile, B.Sc. (Agr.), M.Sc.	Plantes fourragères
A. Frève, B.Sc. (Agr.), M.Sc.	Pommes de terre
R. Rioux,[4] B.A., B.Sc. (Agr.), M.Sc.	Herbicides, malherbologie

Ferme expérimentale, Normandin

J.M. Wauthy, B.Sc. (Agr.)	Surintendant; bovins laitiers
Y. Dion, B.Sc. (Agr.), M.Sc.	Céréales, fines herbes
R. Drapeau, B.Sc. (Agr.), M.Sc.	Plantes fourragères, horticulture

Chercheurs invités

NOËLLE AMARGER, D.Sc. INRA, Dijon, France, Postdoctorat de l'OCDE	Microbiologie
CLAUDE CALDWELL, Ph.D. Station de recherches, Lacombe	Physiologie
KATHERINE S. CLOUGH, Ph.D. Les Tourbières Premier, Rivière-du-Loup, Québec	Endomycorhizes
TONY GLASS, Ph.D. Université de Colombie-Britannique, Vancouver	Physiologie
ANDRÉ LECOQ, Ingénieur agronome, Avignon, France	Physiologie végétale
JEAN MULLER, Maître de recherche, INRA, Chalons sur Marne, France.	Fertilité des sols
T.I. TRUNOVA, D.S. Académie des sciences de l'URSS	Physiologie du froid

Étudiants à la maîtrise

G. ALLARD patron R. Michaud	Amélioration et génétique
F. BÉLANGER patron J.P. Dubuc	Physiologie du développement
Y. BLAIS patron P. Savoie	Génie rural
Y. DION patron A. Comeau	Phytopathologie
S. GAGNÉ patron C. Richard	Phytopathologie
G. LALIBERTÉ patron R. Paquin	Phytotechnie
H. ROUSSEAU patron C. Richard	Phytopathologie
G. SAINDON patron R. Michaud	Amélioration et génétique
R. SAUVAGEAU patron L.M. Bordeleau	Physiologie bactérienne

Étudiants au doctorat

F. BIGRAS patron R. Paquin	Phytotechnie
M. CARON patron C. Richard	Phytopathologie et endomycorhizes
J. COLLIN patron A. Comeau	Amélioration des céréales
S. LABERGE	Génétique bactérienne

patron L.M. Bordeleau	
C. Lafrenière patron L.M. Bordeleau	Physiologie bactérienne
C. Lemieux patron J.M. Deschênes	Écologie des mauvaises herbes
P.N.S. Mnkeni patron M.R. Laverdière	Chimie des sols
C. Thériault patron A. Comeau	Hybridation interspécifique
L.P. Vézina patron H.J. Hope	Phytotechnie

---

[1] Détaché de la Direction générale des affaires financières et administratives, Division des bibliothèques
[2] Prêté, Bureau du Sous-ministre adjoint à la Recherche, avril 1983.
[3] Prêté, Bureau du Sous-ministre adjoint à la Recherche, septembre 1983.
[4] Prêté, Région de l'Atlantique, Surintendant intérimaire, Buctouche, N.-B.

INTRODUCTION

La station de recherches à Sainte-Foy, et ses fermes expérimentales La Pocatière, Normandin et Jean-Charles Chapais à Saint-David travaillent surtout à résoudre les problèmes agricoles du centre du Québec, du Bas Saint-Laurent et du Lac Saint-Jean. Les programmes de recherches sont orientés vers les différents aspects de la production des plantes fourragères, des céréales, des bovins laitiers, des ovins, des pommes de terre, des arbres fruitiers et de certains petits fruits. On y poursuit également des recherches en fertilité, en chimie, en génèse et en minéralogie des sols.

Ce rapport offre un bref aperçu des résultats obtenus en 1983. Pour de plus amples informations, veuillez vous adresser à: Station de recherches, Agriculture Canada, 2560 boulevard Hochelaga, Sainte-Foy, Québec. G1V 2J3.

S.J. Bourget
Directeur

LES PLANTES

Les plantes fourragères

Légumineuses. La majorité du matériel sous évaluation a été détruit au cours de l'hiver 1982-83. Des résultats d'évaluation de certaines populations expérimentales ont quand même été obtenus sur un nombre limité de sites et tout laisse croire qu'il y aura éventuellement la possibilité de faire une demande d'homologation pour un nouveau cultivar si les tendances observées cette année se poursuivent. De la semence du cultivar de luzerne Apica, homologué en 1982, a été produite en 1983. Les agriculteurs de l'est du Canada pourront se procurer ce cultivar pour la première fois en 1984.

Les conditions rigoureuses de l'hiver 1982-83 en détruisant considérablement les luzernières ont permis toutefois de recueillir des plants dont la résistance sera évaluée et qui pourront éventuellement être utilisés dans le programme d'amélioration.

Une population de luzerne sélectionnée dans la glace en présence de *Fusarium* s'est avérée plus rustique lors d'une épreuve de descendance en laboratoire. Au champ, plusieurs lignées expérimentales de luzerne ont montré, après deux hivers particulièrement rigoureux, un degré plus élevé de persistance et de résistance aux *Fusarium* des racines. Un progrès sensible a été accompli en effectuant 2 cycles de sélection de la luzerne pour développer la résistance aux flétrissements fusarien et verticillien.

Les bactéries isolées des graines et des racines saines et malades de la luzerne appartiennent aux genres *Pseudomonas* et *Xanthomonas*.

La sélection de la luzerne en vue de la résistance à la maladie des nodosités de racine, dite aussi maladie des racines noueuses, causée par le *Meloidogyne hapla Chitwood* s'est poursuivie et l'étude du seuil de nuisibilité de cette espèce est amorcée.

Graminées. Une étude sur la variabilité génétique de la fléole des prés pour déterminer des propriétés physiques reliées à l'ingestion a démontré qu'il existe des différences entre les génotypes à l'intérieur des cultivars et que ces propriétés physiques sont influencées par le développement physiologique de la plante. Le degré de transmission de ces caractères et leur utilisation dans un programme d'amélioration restent encore à déterminer.

Les essais entrepris en 1979 et en 1982 à La Pocatière et en 1982 à Joliette qui ont pour but de développer des techniques culturales de production de semences de fléole démontrent, si on se fie aux résultats obtenus en 1982 et en 1983, que le mode et la période de semis ainsi que les doses d'azote sont les principaux facteurs qui gouvernent la productivité en semence de la fléole. La fléole semée au printemps ou à l'automne avec une plante-abri donne beaucoup moins de semences qu'en semis pur; des différences de 100 à 300 kg/ha ont été observées. La production de semences augmente avec chaque dose croissante d'azote (de 0 à 100 kg/ha de N_2) mais les rendements ne sont pas, dans l'ensemble, statistiquement différents à des doses supérieures à 50 kg/ha de N_2. La fléole établie dans les rangs espacés de 36 cm ou de 54 cm donne plus de semences et est plus persistante que la fléole semée à la volée. Ces mêmes facteurs affectent aussi les composantes du rendement en semences (la longueur, le nombre et le rendement par épis), notamment la densité des épis qui est, parmi toutes les composantes sous étude, celle qui explique la plus grande partie de la variation du rendement.

Une étude sur le comportement de la fléole des prés durant sa phase reproductrice a débuté en 1982. La détermination séquentielle du rendement en semences par épis, du nombre d'épis selon quatre classes de longueur et du taux de germination des caryopses a été effectuée au champ et en laboratoire. Une des causes de la coulure des graminées chez la fléole a été identifiée: il s'agit du *Fusarium poae* qui a souvent été reconnu chez d'autres graminées.

Mélanges fourragers. L'étude sur la productivité, la persistance et la contribution de la fléole au rendement en herbe d'un mélange fourrager bispécifique et sur la qualité nutritive du fourrage a été poursuivie pour la dernière année en 1983 à quatre sites expérimentaux. Les derniers résultats compilés (1982) indiquent que la contribution des légumineuses aux rendements des mélanges luzerne—fléole et trèfle rouge—fléole a diminué tandis que celle de la graminée a augmenté avec chaque accroissement de la dose d'azote. Un meilleur équilibre entre les espèces cultivées est obtenu lorsque 112 kg/ha d'azote sont appliqués sur les mélanges fourragers. Les rendements totaux des mélanges fourragers ont augmenté avec les doses d'azote.

Mauvaises herbes. Environ 300 prairies et pâturages ont été inventoriés en 1983 dans la région de l'Outaouais. L'aspect descriptif et quantitatif des mauvaises herbes dans les régions du Bas Saint-Laurent, de la Beauce, de Québec, de Nicolet, de la Mauricie, du Lac Saint-Jean et de l'Abitibi—Témiscamingue a été préparé et les rapports distribués dans chaque région.

Une densité de 400 plants de chénopode blanc au mètre carré affecte l'établissement de la luzerne. La période critique d'interférence se situe entre la 4^e et la 6^e semaine après le semis. Des études sur les seuils de nuisibilité et sur la période critique d'interférence de groupes d'espèces de mauvaises herbes ont aussi été entreprises en relation avec la fléole des prés. Les travaux sur le cycle de croissance de l'ortie royale, la spargoute des champs, la sétaire glauque et le chénopode blanc montrent que chaque espèce possède sa propre stratégie de croissance et de reproduction. Cependant, les quatre espèces réagissent au stress de la densité en devenant plastiques au lieu de mourir.

Récolte et conservation. Un projet de recherche sur le séchage des fourrages au champ a commencé en 1983 en collaboration avec la station de recherches de Deschambault et avec le département de génie rural à l'Université Laval. Une meilleure compréhension du séchage des fourrages permettra de choisir les méthodes de récolte et de conservation les plus appropriées sous diverses conditions climatiques.

La simulation des chaînes fourragères fait l'objet d'une recherche à long terme. Si on intègre la croissance des plantes, la récolte, la conservation et l'alimentation à des ruminants dans un modèle mathématique, on pourra évaluer l'effet de différentes technologies ou méthodes de gestion sur l'ensemble du système.

La survivance à l'hiver

Influence du climat. L'acquisition de la tolérance au gel (TL_{50}) des espèces fourragères et des céréales cultivées à La Pocatière et Saint-Hyacinthe a été plus tardive en automne 1982, suite à des températures plus élevées qui ont prévalu dans la plupart des régions, surtout dans la région de Montréal. Les premières gelées sont apparues entre le 10 et le 12 octobre et les suivantes entre le 23 et le 27 octobre, tant à La Pocatière qu'à Saint-Hyacinthe. Malgré ce retard, les cultivars ont acquis une tolérance au gel presque équivalente à celle des années prédédentes, à l'exception des céréales atteintes par le virus de la jaunisse nanisante, particulièrement à La Pocatière. À cause de l'absence de neige et de la température plus froide à cet endroit, les TL_{50} des cultivars ont atteint un maximum au début de décembre et, à Saint-Hyacinthe, au début de janvier 1983.

Ces maximums ont été respectivement à La Pocatière et Saint-Hyacinthe de -2 et -25°C pour la luzerne Rambler, de -30 et -31°C pour le brome Saratoga, de -32 et -33°C pour la fléole Engmo, de -30 et -27°C pour le seigle Cougar, de -24 et -20°C pour le blé Kharkov et de -26 et -21°C pour le triticale Wintri. Le brome Sarotoga et la fléole Engmo sont les deux cultivars qui ont maintenu leur tolérance au gel le plus longtemps, soit jusqu'au milieu de mars 1983.

À cause des faibles accumulations de neige un peu partout dans la province, la température du sol à 5 cm de profondeur est demeurée plus basse que la normale qui est habituellement de -0,5 à -1°C. La différence a été plus marquée à La Pocatière où la température a fluctué entre -3 et -7°C au cours de la saison, avec deux périodes où elle s'est abaissée à -12 et -13°C pendant 4 à 5 jours. La glace et les basses températures ont rendu les cultivars moins résistants à l'hiver. Seule la fléole Engmo a résisté à 100% alors que les pourcentages de survie du brome Saratoga et de la luzerne Rambler étaient de 90 et de 10 respectivement. À Saint-Hyacinthe, la température du sol a oscillé entre -2 et -3°C et le minimum de -6°C a été observé le 6 janvier 1983. Dans cette région, la température de l'air a atteint -31°C le 11 février, mais la couche de neige au sol de 16 cm a été suffisante pour garder la température du sol à -3°C.

Les céréales ont souffert plus que les plantes fourragères des conditions de l'hiver 1982-83, particulièrement à La Pocatière. À cet endroit, la survie du seigle Cougar fut de 25% et de 70% à Saint-Hyacinthe. Celle du triticale Wintri a été respectivement de 20 et de 50%, et du blé Kharkow de 0 et 25%.

En général, les dommages sont apparus très tôt dans la saison, surtout lorsqu'il y avait de la glace. Le 20 décembre 1982, le blé Kharkov était déjà mort à La Pocatière et la survie de la luzerne Rambler n'était plus que de 6%. Quant à la fléole Engmo réputée pour sa grande résistance à la glace, sa survie a atteint à peine 12% à la fin de la saison hivernale.

Un projet sur la survie à l'hiver du fraisier et du pommier a été entrepris avec l'implantation de ces espèces sur la ferme Chapais, en collaboration avec la station de Saint-Jean. Le but du projet est de trouver une méthode de sélection pour rendre ces deux espèces plus résistantes à l'hiver.

Un autre projet a également été entrepris pour comparer la résistance à la glace de plusieurs espèces indigènes et de deux cultivars, un de l'Agropyron et un de l'Elymus avec le seigle comme témoin. Après 2 semaines sous une couche de glace, le cultivar d'Elymus, le Prairieland (*E. angustus*), survivait à 100%, et celui de l'Agropyron, l'Orbit (*A. Elongatum*), à 91%. La survie du seigle Puma (témoin) n'était que de 4%. Après 4 semaines sous une couche de glace, la survie de ces espèces était de 65% pour l'Orbit, de 100% pour le Prairieland et de 0% pour le Puma. À la suite de ces résultats, on espère transférer au blé les gènes de résistance des deux espèces indigènes.

Mécanismes de la résistance au froid. Des phosphérosomes de 0,2 à 0,4 μm de diamètre sont formés *de novo* dans le réticulum endoplasmique de tissus méristématiques de racines de luzerne soumises à des températures de +2 à −10°C. Ces proplastes de nature lipoprotéique se transforment en sphérosomes et seraient impliqués dans les mécanismes d'endurcissement au froid au niveau des membranes.

L'examen morphologique et histologique des bourgeons de collets de luzerne échantillonnés au cours de l'hiver 1982-83 montre que l'alternance de gels et de dégels a causé la destruction de ces bourgeons au cours de janvier et février 1983.

La matière sèche a augmenté parallèlement à l'acquisition de la tolérance au gel chez les plantes fourragères et les céréales cultivées à La Pocatière et à Saint-Hyacinthe en 1982-83. La plus faible augmentation a été observée chez la luzerne Rambler, soit 20%, et la plus forte chez le seigle Cougar, soit plus de 100%. Durant la même période, la teneur en proline libre et en sucres a également augmenté. La proline a augmenté de 10 à 45 fois chez les graminées fourragères et de 3 à 10 fois chez les céréales. La teneur en sucres (sucrose + sucres réducteurs) de tous les cultivars a augmenté de 1,3 à 3,3 fois et le maximum d'augmentation a, dans presque tous les cas, coïncidé avec le maximum de la tolérance au gel, entre le début février et le début mars. Les sucres réducteurs comptent peu dans cette augmentation chez les plantes fourragères, de 3 à 20%, mais chez les céréales les proportions sont de 50 à 65% par rapport au sucrose. On pourrait croire que l'acquisition de la tolérance au gel (TL_{50}) est liée particulièrement à l'augmentation du sucrose, mais comment expliquer que la TL_{50} du seigle Cougar est presque aussi élevée que celle du brome Saratoga et de la fléole Engmo.

La putrescine, une polyamine susceptible de jouer un rôle dans l'endurcissement au froid, augmente de 3 à 4 fois dans les feuilles du blé rustique Kharkov après 8 h à 2°C et l'augmentation se maintient pendant 60 heures. Cependant, cette polyamine n'augmente pas chez le blé sensible Champlain soumis aux mêmes conditions de température. D'autres polyamines telles que la cadavérine, la spermine et la spermidine sont peu abondantes ou sont à la limite de la détection.

L'énergie: fixation d'azote et endomycorhizes

Métabolisme. La méthode isotopique développée pour mesurer l'attachement des cellules du *Rhizobium* aux racines de luzerne nous a permis de vérifier les effets des ions NO_3 et NH_4 sur la nodulation; le nitrate agit sur le métabolisme de la plante dès la première étape du processus symbiotique et diminue l'adsorption du *R. meliloti* à des concentrations de 5 et 16mM; l'ammonium à une concentration de 1,0 mM a un effet stimulateur. À l'aide des isotopes radioactifs ^{11}C et ^{13}N, nous avons démontré que l'ammonium et/ou le nitrate inhibe(nt) jusqu'à 50% l'activité de la nitrogénase (l'enzyme responsable de la fixation symbiotique de l'azote atmosphérique) après seulement 20 min d'exposition et que cette inhibition persiste pendant 24 h; l'inhibition s'exerce à partir de dose équivalentes à 30 ppm d'azote. Nous avons aussi démontré que de 20 à 40% du carbone total de la plante peut être incorporé par les racines nodulées avec le *Rhizobium* dans les composés azotés par fixation de $^{13}N_2$ et $^{11}CO_2$. Ce fait a des conséquences importantes pour la compréhension des mécanismes de fixation symbiotique de l'azote atmosphérique en relation avec les cycles carbone— azote dans la luzerne.

Fixation d'azote à basse température. Nous avons isolé 48 *Rhizobium* de l'Arctique qui nodulent trois espèces de légumineuses arctiques et le sainfoin. Les tests d'inoculation croisés indiquent une homologie de ces souches dans la nodulation des *Oxytropus*; la majorité nodulent aussi l'*Astragallus cicer* et seulement deux nodulent le *Medicago sativa*. Les profils de résistance aux antibiotiques et des plasmides montrent de grandes diversités entre les isolats, de même que l'activité nitrogénasique évaluée sur le sainfoin. La caractérisation physiologique de cette population de *Rhizobium* arctiques indique leur adaptation aux basses températures. De plus, la majorité des isolats montrent une activité inducible de réduction de l'acétylène *ex-planta*. Cette population de *Rhizobium* ne ressemble pas aux autres populations de ce genre décrites dans des publications.

Banque de Rhizobium. Afin d'accroître notre banque de collection de *Rhizobium* pour permettre la sélection de souches adaptées à nos conditions climatiques et à nos légumineuses, nous avons isolé: 30 souches de *R. leguminosarum* à partir de 18 cultivars différents de gourgane (*Vicia faba* var. *major*) venant de différentes régions; 36 souches *R. leguminosarum* à partir de 12 cultivars différents de pois (*Pisum sativum*) de différentes régions; 66 souches de *R. phaseoli* à partir de 29 cultivars différents de fèves jaunes et/ou vertes (*phaseolus vulgaris*).

Endomycorhizes. Dans notre projet sur les endomycorhizes VA associés à des plantes agricoles, nous avons testé trois espèces de champignons endomycorhiziens sur deux cultivars de luzerne et nous avons mis en culture deux nouvelles espèces de ces champignons. Nous avons mis sur pied un projet biotechnologique pour la production commerciale d'inoculum endomycorhizien et la mise au point d'un substrat porteur, ce projet est mené en collaboration avec la firme Les Tourbières Premier.

LES CÉRÉALES

Amélioration. Avec l'arrivée d'une compagnie privée en amélioration des céréales, nos efforts de recherches se diversifient et changent légèrement d'orientation. En plus de l'avoine et de l'orge, le projet comprend le blé et le triticale, le développement de génotypes remplace partiellement la production de cultivars. La majorité des nouveaux croisements faits avec l'orge et l'avoine visent à développer de nouveaux types tels la force de la paille par l'introduction de gènes de nanisme, la résistance à l'acidité chez l'orge pour augmenter son adaptation et la germination à basse température également chez l'orge. On a effectué 95 croisements chez le blé et le triticale pour les adapter à nos conditions de croissance et accroître leur aire d'adaptation. Plus de 5000 orges et avoines ont été évaluées en 1983, dont 4000 pour une première année. L'excellent rendement et l'adaptation des lignées en tamisage 82 ont permis d'aider les compagnies de semence à entreprendre des programmes d'amélioration en distribuant sept lignées supérieures à quatre compagnies intéressées. En essais d'homologation, les lignées de Sainte-Foy continuent à se classer aux tout premiers rangs dans l'est du Canada. La lignée d'avoine Q0191.70 se classe première dans les Maritimes, la Q0186.10, première en Ontario et la Q0188.36, première au Québec. Pour l'orge, la lignée QB185.3 a le meilleur rendement au Québec.

Pathologie. Systématiquement, dans les essais coopératifs de l'Est et dans les essais régionaux, les cultivars sont notés pour leur réaction aux diverses maladies qui sévissent au Québec. Il est intéressant de noter que les lignées d'avoine de Sainte-Foy, la Q0199.27 et la Q0199.60, se sont révélées parmi les moins sensibles au charbon, à la tache septorienne, à la rouille couronnée et à la jaunisse nanisante dans les essais coopératifs. Dans les essais régionaux, les cultivars OAC Woodstock et Dumont se sont montrés résistants à la rouille couronnée; le Dumont et l'Oxford étaient moins sensibles à la jaunisse nanisante et l'OAC Woodstock et le Lamar étaient moins sensibles à la tache septorienne.

Des épreuves de rendement ont révélé que la contamination fusarienne des semences entraîne des baisses de rendement chez l'orge. La sensibilité à cette contamination varie avec l'espèce; l'orge étant la plus sensible, suivi du blé qui a une réaction intermédiaire et de l'avoine qui n'est pas affectée.

L'évaluation des ressources phytogénétiques, pour leur réaction au virus de la jaunisse nanisante (VJNO) à Sainte-Foy, est le projet le plus important du genre au niveau mondial et cette collaboration permet de fournir des blés résistants au VJNO aux pays en voie de développement par CIMMYT et ICARDA. L'*Avena occidentalis* possède une excellente résistance au VJNO et se croise facilement avec l'avoine cultivée. Le cultivar d'orge d'automne «Post» possède une excellente résistance au VJNO et cette résistance provient d'un gène différent de Yd_2.

Malherbologie. Les inventaires de mauvaises herbes se sont poursuivis dans l'Outaouais par l'examen de plus de 400 champs de céréales. Comme dans les autres régions, il semble que le chiendent, le laiteron des champs, l'ortie royale, la marguerite et la moutarde des champs soient les mauvaises herbes les plus présentes. L'analyse des résultats se poursuit.

LES SOLS

La fertilité

Assimilabilité de l'azote. Un essai utilisant la technique du ^{15}N a été effectué en serres en vue de déterminer la capacité de 10 sols de Québec à fournir de l'azote minéral aux plantes. La teneur des sols en matière organique (M.O.) a varié de 2,96 à 9,67%. Plusieurs doses d'azotes (N) ont été administrées avec un excès de ^{15}N de 4,4%. Tous les pots ont reçu une fertilisation uniforme en P et K. Trois cultures successives d'avoine ont été récoltées au stade de floraison. Les résultats démontrent que les rendements en matière sèche (M.S.) à N^o ainsi que les rendements maximaux ont été plus élevés avec l'augmentation en M.O. des sols ($r = 0,81$ et respectivement 0,80). L'azote exporté par les plantes a été lui aussi significativement corrélé avec la M.O. ($r = 0,86$), mieux que les rendements en M.S. L'efficacité de l'azote, exprimée en gain de M.S. par unité de N administrée, a été plus élevée sur les sols plus riches en M.O. ($r = 0,88$) où les conditions physico-chimiques et microbiologiques étaient plus propices à une meilleure utilisation des engrais et par conséquent, à un rendement élevé. Ainsi, les régressions multiples pour les rendements en M.S. ont démontré une interaction M.O. × N significative. Cette interaction a causé 81% de la variation du rendement, suivie des doses de N. Une forte corrélation multiple a été ainsi obtenue ($r = 0,95$). Dans le cas de l'azote exporté, ce sont les doses d'azote qui ont causé la majeure partie de la variation (93%), suivies par la M.O.

Le pourcentage d'azote dérivé de l'engrais azoté (%Ndff) s'est accru avec l'augmentation de la dose de N, tandis que le pourcentage d'utilisation de l'azote appliqué a diminué. On n'a pas remarqué un effet de «priming», même à des doses plus faibles. Les valeurs «A» suggèrent que l'assimilabilité de l'azote du sol aussi bien que celui des engrais a varié avec la variation de la dose d'azote administrée.

Amendements organiques. L'effet résiduel de trois amendements organiques sur les rendements de l'avoine a été mesuré pour une troisième année au champ. La plus forte dose de fumier a donné un rendement de 133% par rapport au témoin. Le compost a entraîné une faible augmentation des rendements tandis qu'une diminution a été notée pour les traitements de mousse de tourbe. Les rendements de l'orge ont été mesurés pour une deuxième année. Les plus fortes doses de mousse de tourbe, compost et fumier ont donné des rendements relatifs de 124%, 108% et 124% respectivement.

Cinq mélanges tourbe—sable—vermiculite ont eu peu d'effets sur les rendements de la tomate, de la laitue et du radis cultivés en serre. Les mélanges évalués ont été inférieurs à deux terreaux commerciaux. Les cultures étudiées ont bien répondu à un apport de chaux jusqu'à une dose de 5 kg/m^3.

La pédogénèse

Physique du sol et productivité. Des essais ont été effectués en serres sur des échantillons constitués d'horizons A, B, C purs ou de mélanges d'horizons provenant de deux sols bruns calcaires et de quatre sols gris (acides à neutres) argileux de l'Abitibi. L'effet simulé du labour et l'influence de l'addition de 10 t de carbone à l'hectare, appliqué sous forme de fumier ou de mousse de tourbe ont été évalués en comparant les rendements obtenus pour trois récoltes successives d'avoine. Tous les sols avaient reçu une fertilisation identique avant chaque semis. Les rendements maximaux ont été observés pour les échantillons A purs et décroissaient généralement à mesure que les proportions d'horizons B et C augmentaient dans les mélanges à cause d'un accroissement marqué des teneurs en argile. L'argile avait des valeurs de densités plus élevées (1,59 g/cc versus 1,41 g/cc). Dans les sols bruns, les variations texturales entre les horizons A et les couches sous-jacentes étaient moins marquées et l'addition de matériel provenant de l'horizon C avait un effet bénéfique sur les rendements suite à l'accroissement du pH. L'apport de matière organique a contribué à accroître légèrement les rendements en avoine et à diminuer la densité apparente des sols de 9% par comparaison avec les témoins. De plus, bien qu'on ait observé des accroissements de la CEC, du P assimilable et du pourcentage en M.O. à la fin des essais, les rendements ont généralement diminué de la première à la troisième récolte, sans doute à cause d'une détérioration de l'état physique du sol et de la faible disponibilité du K échangeable suite à une fixation irréversible de cet élément.

Chimie des sols et minéralogie. Quatorze horizons de surface provenant de sols agricoles du Québec ont été utilisés pour effectuer des adsorptions de phosphore et pour vérifier l'applicabilité de cinq modèles mathématiques (à la description du phénomène). Ces sols adsorbaient de 640 à 1360 μgP/g de sol pour des additions de P de l'ordre de 1800 μg/g de sol. Les sables loameux et les loams sableux adsorbaient généralement les quantités les plus fortes de P. Bien que les modèles plus sophistiqués de Langmuir—double site ainsi que des versions modifiées de Langmuir—simple ou de Freundlich—simple semblaient mieux décrire l'adsorption de P sur une base statistique, les valeurs de maxima d'adsorption calculées par la méthode traditionnelle de Langmuir étaient celles qui se rapprochaient le plus des valeurs observées.

Une étude a été effectuée sur trois profils de sols (Arago, Calder, Sainte-Agathe) contenant des horizons plus ou moins indurés. Des solutions extractives ont été utilisées afin de caractériser la nature des ciments. La méthode du dithionite—citrate—bicarbonate modifiée s'est avérée meilleure que les méthodes CDB traditionnelles et le NaOH bouillant pour extraire le Fe, l'Al et le Si impliqués dans la cimentation des horizons.

Géochimie et genèse. On a procédé à l'étude d'un saprolite dérivé d'un gneiss dans une zone de faille à Charlesbourg. La position de ce matériel altéré sous une couche de till suggère une altération pré-glaciaire sous des conditions climatiques plus chaudes que les conditions actuelles. Des couches enrichies en oxydes de Fe contenaient jusqu'à 15% de goethite et/ou de lépidocrocite. Trois faciès décrits dans ce matériel sur une base de couleurs et de litage ont montré la dominance dans la fraction argileuse de kaolinite, de kaolinite + gibbsite et de minéraux gonflants de type 2:1 associés à la kaolinite. Le degré de transformation des minéraux de type 2:1 en kaolinite puis en gibbsite paraît associé au drainage interne.

FERME EXPÉRIMENTALE LA POCATIÈRE

Les plantes fourragères

Production de semence du trèfle rouge. La production de semence du trèfle rouge pour une surface donnée est évidemment fonction d'une population valable de plants. Les dommages causés par l'hiver aux semis de trèfle rouge ont été très importants. Les rendements mesurés ont donc été très faibles. La présence d'abeilles caucassiennes n'a pas semblé augmenter davantage la production de graines des populations éparses de trèfle rouge. Cet insecte pollinisateur ne semble pas apprécier beaucoup cette espèce.

Régie du semis. Le semis de plantes fourragères dans un tapis végétal déjà existant est une technique délicate d'application. Cette année, comme nous avons eu un printemps froid, très humide et trop long, ce qui a retardé de beaucoup les semis et un été soudain, très sec et chaud, nous n'avons pas eu de succès avec les semis directs.

Besoins en azote. L'association légumineuse—graminée a toujours été bénéfique à la production herbagère. Outre l'amélioration apportée à la qualité du fourrage, le transfert possible d'azote de la légumineuse à la graminée peut être la raison la plus valable à l'avantage réciproque de leur culture conjointe. L'association luzerne—fléole a subi une diminution très importante de sa population de luzerne sur l'argile Kamouraska. Sur le loam Saint-André, cette association était encore valable en 1983. Cependant la sécheresse sévère de l'été n'a pas permis d'observer d'effet positif qui serait dû à l'association entre la légumineuse et la graminée.

Essais de cultivars. Plusieurs lignées et cultivars de différentes espèces fourragères sont évalués à chaque année. Leur évaluation a permis d'homologuer le cultivar de luzerne 532 résistant à la flétrissure bactérienne et fusarienne ainsi que le cultivar de fléole Hokuo. L'analyse des résultats d'essais de dactyle a permis d'ajouter à la liste des recommandations les cultivars Sumas et Orion.

Les pommes de terres

Amélioration. L'amélioration génétique de la pomme de terre s'est poursuivie en 1983 à La Pocatière. Une cinquantaine de croisements ont été réalisés. Des lignées produites en 1982, 12 000 ont été évaluées au champ et 1 275 ont été sélectionnées. Des lignées sélectionnées à Frédéricton au stade 4-buttes, 1 110 ont été évaluées sur deux sols différents (Saint-André et de l'Anse) et 302 ont été sélectionnées au champ et formeront les LP84. Des lignées évaluées pour la seconde année, soit les LP83, 66 ont été évaluées sur trois sols différents (Saint-Pacôme) et les meilleures seront épurées en 1984. Un essai d'adaptation a été effectué à La Pocatière sur trois sites, avec les lignées LP81 (7) et LP82 (16) qui n'avaient pas encore été essayées dans le réseau d'essai. Dans le réseau d'essai, la 10 LP80 et la 19 LP81 ont été évaluées dans les essais hâtifs et avancés d'adaptation.

Enquêtes et parcelles de démonstration. Une enquête sur le développement des potagers (17,2 ha) et ceux ayant des pommes de terre (70%) a eu lieu dans la région de Kamouraska, de Saint-Arsène, de l'Isle-Verte, de Saint-Eloi, en 1983. De nombreux potagers voisinaient les champs de semence de pomme de terre dont ils n'étaient séparés que par une clôture. Le flétrissement bactérien a été diagnostiqué dans certains potagers. Les pommes de terre des potagers de la région de Kamouraska étaient les plus saines et c'est dans cette région que la semence certifiée était la plus employée. Plusieurs variétés sont produites; de très vieilles comme la Early-Rose et de nouvelles qui ne sont pas homologuées pour la vente au Canada ont également été dénombrées.

En collaboration avec le Centre de Certification et d'Épuration de la pomme de terre des parcelles de démonstration ont été faites avec tous les cultivars homologués au Canada et ailleurs, et certaines lignées adaptées aux conditions du Québec (75). Elles servaient entre autre à entraîner des élagueurs et des professionnels à reconnaître les cultivars.

Des tests sérologiques pour combattre les maladies virales ont été faits en collaboration avec le Centre de Certification afin de déterminer la qualité phytosanitaire des pommes de terre de semence du Québec. Les résultats obtenus ont confirmé la haute précision de dépistage de ces tests de laboratoire et ils ont permis d'établir des critères de base pour trouver des compromis entre les tests sérologiques et l'évaluation visuelle lors des inspections.

Les vergers

Les maladies dans les vergers (pomme, prune et poire) ont été pratiquement inexistantes, sauf la tavelure d'automne qui a attaqué les pommiers. Les rendements ont été moyens, mais le calibre des fruits a été plus petit.

Les ovins

Cueillette des données en production ovine. Un projet de recherche à contrat afin de démontrer l'importance des problèmes de santé qui existent dans la production ovine dans la région de Saint-Hyacinthe a été terminé durant l'année. L'étude couvrait 12 fermes d'élevage qui possédaient un cheptel de 50 à 200 têtes et 3 fermes de 200 têtes et plus ont eu un faible taux de prolificité (1,25 à 1,61). On a relevé une mortalité de 13,7% pour les agneaux et 5% chez les adultes. La principale cause de mortalité chez les agneaux et adultes est de nature respiratoire et l'ensemble des problèmes dans les élevages étudiés seraient reliés à l'alimentation et à l'environnement dans lequel vivent les animaux.

FERME EXPÉRIMENTALE NORMANDIN

Les céréales

Un essai de défanants est mené pour la première année afin de savoir si l'on peut hâter la maturité du blé de printemps; cinq herbicides appliqués à différents taux comparés au témoin et à l'andainage ont été évalués. Les résultats préliminaires montrent des pertes de rendement et un pourcentage d'humidité élevé à la récolte pour le traitement d'andainage. Ceci est surtout occasionné par les conditions atmosphériques qui ont prévalu durant cette période. Les autres traitements ne permettent pas encore de tirer des conclusions.

Le premier rapport des essais d'évaluation du blé de printemps dans les régions périphériques est produit pour les essais de 1983 de blé et de triticale. Le rapport comprend des essais d'observation, de préliminaire et de tamisage. Des essais de pré-observation, la sélection et les croisements (plus de 160 en 1983) se poursuivent.

On a étudié durant 4 années l'effet, en traitements simples et combinés, des modes de fertilisation (à la volée versus en bande), du rechaussement et de la présence d'un paillis sur la production d'une souche locale de gourgane (Vicia Faba L. var. major). Les résultats démontrent que le rendement moyen en gousses vertes, le nombre moyen de gousses à l'hectare, le nombre moyen de gousses par plant, trois variables interdépendantes, ainsi que le pourcentage occupé par le grain dans la gousse, le rendement en grain vert et le rendement en matière sèche des chaumes après récolte n'ont pas été modifiés de façon significative par les variantes de régie appliquées. L'effet des traitements a varié avec les années. Les variations obtenues dans le rendement en matière sèche du chaume et le nombre de gousses par plant semblent indiquer que la production de la gourgane est reliée aux conditions climatiques qui prévalent pendant la croissance des plantes et en particulier pendant la période de floraison.

PUBLICATIONS

Recherche

Batra, T.R.; McAllister, A.J.; Chesnais, J.P.; Darisse, J.P.F.; Emsley, J.A.B.; Lee, A.J.; Roy, G.L.; Veseley, J.A.; Winter, K.A. 1983. Comparison of the heifer reproduction traits of the daughters of several sire groups. Can. J. Anim. Sci. 63: 269-278.

Batra, T.R.; McAllister, A.J.; Lee, A.J.; Lin, C.Y.; Roy, G.L.; Vesely, J.A.; Wauthy, J.M.; Winter, K.A. 1983. Body weights and dimensions of pureline and crossline heifers of the Canadian Dairy Cattle Breeding Project. Can. J. Anim. Sci. 63: 511-522.

Bernier-Cardou, M.; Garant, E.; Michaud, R. 1983. Allocation optimale des ressources pour des essais de céréales au Québec. Can. J. Plant Sci. 63: 889-894.

Bolduc, R.; Couture, L. 1983. Conditions aseptiques pour l'endurcissement au froid de plantules de blé d'automne et de luzerne. Cytologia 48: 581-595.

Bolduc, R. 1983. Influence de la température sur les membranes de sphérosomes de cellules méristématiques de luzernes. J. Can. Bot. 6: 2112-2118.

Chestworth, W.; Dejou, J.; DeKimpe, C.R.; Larrocque, P.; Vasquez, F.M.; Garcia-Paz, C.; Garcia Rogeja, E. 1983. Étude comparative des processus de fersiallitisation et d'andosolisation développés sur basaltes du Massif Central français. C.R. Acad. Sci. Paris, 296: 1651-1654.

Comeau, A.; St-Pierre, C.A. 1983. Evaluating cereals for barley yellow dwarf virus resistance: an international approach. Can. J. Plant Pathol. 5: 203-204.

Couture, L. 1983. Rendement en grains de parcelles de céréales de printemps originant de semences contaminées par des Fusarium spp. Canadian J. Plant Sci. 63: 617-621.

DeKimpe, C.R.; Laverdière, M.R.; Dejou, J. 1983. Distribution of silica, sesquioxides, and clay in Quebec Podzolic soils and their effects on subsoil cementation. Soil Sci. Soc. Am. J. 47: 838-840.

Drapeau, R. 1983. Étude de l'effet des modes de fertilisation, du rechaussement et d'un paillis sur la production de la gourgane (Vicia faba L. var. major) au Saguenay-Lac St-Jean. Can. J. Plant Sci. 63: 365-370.

Furlan, V.; Fortin, J.A.; Plenchette, C. 1983. Effects of different vesicular-arbuscular mycorrhizal fungi on growth of *Fraxinus americana*. Can. J. For. Res. 13: 589-593.

Gagné, S.; Antoun, H.; Richard, C. 1983. Antagonisme des bactéries telluriques envers le Verticillium albo-atrum et d'autres champignons pathogènes de la luzerne. Phytoprotection 64: 90-91.

Gasser, H.; Belzile, L.; Michaud, R.; Bordeleau, L.; Faust, N. 1983. Effects of seed coating and inoculation on the establishment and performance of alfalfa. Nat. Can. 110: 71-76.

Isfan, D. 1983. Corn nitrogen rate forecasting based on soil water and expected yield-increase. Commun. Soil Sci. Plant Anal. 14(11): 1101-1117.

Isfan, D.; Zizka, J. 1983. Nitrogen-uptake by plants following soil incubation. Commun. Soil Sci. Plant Anal. 14(6): 451-462.

Kodama, H.; DeKimpe, C.R. 1983. Ferruginous swelling clay minerals in a gabbro saprolite from Mount Megantic, Quebec. Can. J. Soil Sci. 63: 143-148.

Landry, B.; Comeau, A.; Minirelle, F.; St-Pierre, C.A. 1982. Résistance génétique au virus de la jaunisse nanisante de l'orge chez l'avoine. Phytoprotection 63: 36-37.

Lasalle, P.; DeKimpe, C.R.; Laverdière, M.R. 1983. Altération profonde pré-glaciaire d'un gneiss à Charlesbourg, Québec (Canada). Géoderma, 31: 117-132.

Lee, A.J.; McAllister, A.J.; Batra, T.R.; Darisse, J.P.F.; Emsley, A.E.; Roy, G.L.; Winter, K.A.; Veseley, J.A. 1982. Heifer growth in several strains of Holsteins and Ayrshires and in progeny of Ayrshire cows mated to Brown Swiss and Norwegian Red bulls. Can. J. Anim. Sci. 62: 1063-1078.

Lin, C.Y.; Batra, T.R.; McAllister, A.J.; Darisse, J.P.F.; Lee, A.J.; Roy, G.L.; Vesely, J.A.; Winter, K.A. 1983. Differences between sire groups in body measurements and body weight changes of lactating cows. Can. J. Anim. Sci. 63: 27-37.

McKeague, J.A.; Wang, C.; Coen, C.M.; DeKimpe, C.R.; Laverdière, M.R.; Evans, L.J.; Kloosterman, B.; Grien, A.J. 1983. Testing chemical criteria for spodic horizons on podzolic soils in Canada. Soil Sci. Soc. Am. J. 47: 1052-1053.

Michaud, R.; Richard, C.; Willemot, C.; Gasser, H. 1982. Apica Alfalfa. Can. J. Plant Sci. 63: 547-549.

Plenchette, C.; Fortin, J.A.; Furlan, V. 1983. Growth responses of several plant species to mycorrhizae in a soil of moderate P-fertility. I. Mycorrhizal dependency under field conditions. Plant and Soil 70: 199-209.

Plenchette, C.; Fortin, J.A.; Furlan, V. 1983. Growth responses of several plant species to mycorrhizae in a soil of moderate P-fertility. II. Soil fumigation induced stunting of plants corrected by reintroduction of the wild endomycorrhizal flora. Plant and Soil 70: 211-217.

Plenchette, C.; Furlan, V.; Fortin, J.A. 1983. Responses of endomycorrhizal plants grown in a calcined montmorillonnite clay to different levels of soluble phosphorus. I. Effect on growth and mycorrhizal development. Can. J. Bot. 61: 1377-1383.

Plenchette, C.; Furlan, V.; Fortin, J.A. 1983. Responses of endomycorrhizal plants grown in a calcined montmorillonnite clay to different levels of soluble phosphorus. II. Effect on nutrient uptake. Can. J. Bot. 61: 1384-1391.

Richard, C.; Bernier-Cardou, M.; Gagnon, C. 1983. Effet du bénomyl sur la persistance de la luzerne. Can. J. Plant Pathol. 5: 125-218.

Richard, C.; Martin, J.G.; Gagnon, C. 1982. Un semoir à caissettes versatile et rapide. Can. J. Plant Sci. 63: 333-335.

Rioux, R. 1983. Effets de la fertilisation azotée, de l'ethephon et de l'huile minérale sur le défanage de la pomme de terre de semence avec le diquat. Phytoprotection 64: 27-30.

Vesely, J.A.; McAllister, A.J.; Lee, A.J.; Batra, T.R.; Darisse, J.P.F.; Roy, G.L.; Winter, K.A. 1983. Evaluation of cow reproduction in the pureline foundation phase of the Canadian Dairy Cattle Breeding Project. J. Dairy Sci. 66: 867-873.

Waithe, W.I.; Renaud, J.; Nadeau, P.; Pallotta, D. 1983. Histone synthesis by lymphocytes in G_0 and G_1. Biochemistry 22: 1778-1783.

Divers

Barnett, G.M.; Rioux, R.; Comeau, J.E. 1982. Les céréales et la préparation du sol. Direction générale de la recherche. Agric. Can. Contribution 1982-5F. 45 p.

Belzile, L.; Desjardins, R. 1983. Établissement des plantes fourragères. Bull. tech. no. 3, 93 p. C.P.V.Q., AGDEX 120-21.

Belzile, L.; Pelletier, H.; Auger, M.; Desjardins, R. 1983. Productivité de la luzerne et de la fléole cultivées en association et en culture pure à La Pocatière, Canadex, 120.10 (sept.) Agric. Can.

DeKimpe, C.R. 1982. Maïs en monoculture et conservation des sols. Canada Agriculture, no. 4, p. 28-30.

Drapeau, R. 1983. Notes bibliographiques sur la culture et la régie du trèfle rouge. C.P.V.Q., AGDEX 120-21. Bull. tech. 2, 50 p.

Dubé, P.A.; Pattey, E.; Castonguay, Y. 1983. Utilisation des prévisions météorologiques à la ferme. Expérience pilote de Nicolet - été 1982. C.P.V.Q., Bull. tech. No 4.

Gagné, S.; Autoun, H.; Richard, C. 1983. Perspective d'utilisation des batéries du sol comme moyen de lutte contre la verticilliose de la luzerne. Pages 32-40. *In* Compte-rendu d'un colloque sur la recherche en agriculture écologique. Collège Macdonald, Sainte-Anne-de-Bellevue (Québec).

Gagné, S.; Antoun, H.; Richard, C.; Bordeleau, L.M. 1982. Interaction entre les bactéries telluriques et quelques champignons phytopathogènes: perspectives de lutte biologique chez la luzerne. Compte-rendu du 32e congrès annuel de la Société canadienne des microbiologistes. Québec (Québec) p. 75.

Martel, C.; Sylvestre, P.; Gosselin, J.; Bois, B.; Langlois, R.; Garneau, M.; Dutil, D.; Frève, A. 1983. Appréciation des variétés de pommes de terre homologuées au Canada et ailleurs 1982. Canadex 161.34.

Richard, C.; Soucy, Y. 1982. (Éditeurs). Rapport de la journée d'information sur la protection des herbages. Herbages, Agdex 600, 49 p., C.P.V.Q.

Rioux, R. 1982. Influence du type de sol sur la répression du chiendent avec la propyzammide dans les luzernières. Canadex 121.641. Agric. Can.

Rioux, R.; Belzile, L.; Deschênes, J.M.; Watson, A. 1982. Régie et lutte aux mauvaises herbes dans les herbages. Rapport de la journée d'information sur la protection des herbages. Herbages, Agdex 600, p. 11-21, C.P.V.Q.

Savoie, P.; Marcoux, A. 1983. Les silos à fourrages et à grains humides. Huitième symposium sur les bovins laitiers, Conseil des productions animales du Québec. pp 43-60.

Station de recherches Saint-Jean-sur-Richelieu, Québec

CADRES PROFESSIONNELS

Administration

C.B. Aubé, B.Sc.(Agr.), M.Sc., Ph.D.	Directeur
R. Crête, L.S.A., M.Sc.	Directeur adjoint
Y. Bonneau	Services administratifs
A. Conti, Doctorat d'État	Chimiste
T. Otis, B.Sc.(Agr.)	Agent d'information

Soutien scientifique

R. Messier[1]	Informatique
I. Wallace,[2] B.A., M.L.S.	Bibliothèque

Fruits

M.J. Lareau, B.Sc.(Agr.), M.Sc.	Chef de section; gestion des cultures
D. Bagnara, D.Sc.(Agr.), Ph.D.	Génétique
N.J. Bostanian, B.Sc., M.Sc., Ph.D.	Acarologie—entomologie
L.J. Coulombe, B.A., B.Sc.(Agr.), M.Sc., Ph.D.	Phytopathologie
R.L. Granger, B.Sc., B.S.A., M.Sc., Ph.D.	Physiologie
G.L. Rousselle, B.A., B.Sc.(Agr.), M.Sc., Ph.D.	Génétique
C. Vincent, B.Sc., M.Sc., Ph.D.	Entomologie

Légumes

J. Belcourt, B.Sc., M.Sc., D.Sc.	Chef de section; entomologie
G. Bélair, B.Sc., M.Sc.	Nématologie
D. Benoît,[3] B.Sc., M.Sc.	Malherbologie
L. Bérard, B.Sc., M.Sc., Ph.D.	Physiologie de la sénescence

G. Boivin, B.Sc., M.Sc., Ph.D.	Entomologie
M.S. Chiang, B.Sc.(Agr.), M.Sc., Ph.D.	Biotechnologie
J.C. Côté,[3] B.Sc., M.Sc.	Biotechnologie
M. Hudon, L.Sc.(Agr.), M.Sc.	Entomologie
B. Landry,[3] B.Sc., M.Sc.	Génétique
P. Martel, B.A., B.Sc., Ph.D.	Toxicologie
B. Vigier, B.Sc.(Agr.)	Gestion des cultures

Génie et sols

A. Bélanger, B.Sc., Ph.D.	Chef de section; chimie des pesticides
R. Chagnon, B.Sc.(Agr.Eng.)	Énergie
J.A. Millette, B.Sc.(Agr.Eng.), M.Sc.	Hydrologie
B. Panneton,[3] B.Sc., M.Sc.	Arrosages aériens
L.E. Parent,[3] B.S.A., M.Sc.	Physique des sols
R. Thériault, B.Sc.(Agr.Eng.), Doc. Ing.	Mécanisation

Ferme expérimentale, L'Assomption

F. Darisse, B.A., B.Sc.	Surintendant
N. Arnold, B.Sc.(Agr.), M.Sc.	Physiologie
M. Caron,[3] B.Sc., M.Sc.	Phytopathologie
M. Dupré, B.A., B.Sc.(Agr.)	Protection
M. Lamarre, B.Sc.(Agr.), M.Sc.	Phytotechnie
I.S. Ogilvie, B.Sc.(Agr.), M.Sc., Ph.D.	Génétique (maïs et tabac)
C. Richer-Leclerc, B.Sc.(Agr.), M.Sc.	Gestion des plantes ornementales

Départ

R. Bernier, B.A., B.Sc.(Agr.)	Gestion des cultures

GOUVERNEMENT DE LA PROVINCE DE QUÉBEC

M. Mailloux, B.S.A., M.Sc.	Entomologie

---

[1] Détaché de la Direction générale des affaires financières et administratives, Division des systèmes et services consultatifs.

[2] Détaché de la Direction générale des affaires financières et administratives, Division des bibliothèques.

[3] Présentement aux études pour l'obtention d'un doctorat (Ph.D.).

INTRODUCTION

La station de recherches de Saint-Jean-sur-Richelieu est le principal centre de recherches sur les plantes horticoles, arômatiques et sur le tabac au Québec. Les travaux sont orientés vers l'amélioration, la production et la protection ainsi que l'identification de nouveaux produits.

Ce rapport fait état des progrès de recherches réalisés en 1983. Les principales réalisations sont l'identification de trois lignées de maïs autofécondées résistantes à la pyrale, la création de deux cultivars de pommiers nains, le Rouville et le Richelieu, résistants à la tavelure, ainsi que d'un cultivar de groseiller, le Selby, dont le rendement dépasse de beaucoup celui des cultivars usités.

Le transfert à l'industrie des résultats de recherches obtenus en laboratoire et au champ continu d'être une priorité. Afin de mieux faire connaître les domaines de recherches de la station, on a engagé un agent d'information.

Le personnel scientifique de la station a supervisé des contrats de recherches impartis à l'industrie privé ou à des universités. Ces contrats sont complémentaires des travaux de recherches de la station. Les chercheurs ont ainsi supervisé 29 contrats de recherches, évalués à environ $2 500 000, dans les domaines de la mécanisation, de l'énergie, de la protection et de la production de plantes ainsi que sur les plantes arômatiques.

On a amélioré les installations des fermes satellites, mais la plus importante est la construction de l'édifice laboratoires—bureaux qui remplacera, en 1984, le complexe d'édifices existants.

Ce rapport donne un bref aperçu des résultats de recherches obtenus en 1983. Pour de plus amples renseignements sur nos réalisations, vous pouvez écrire à l'adresse suivante: Station de recherches, Direction générale de la recherche, Agriculture Canada, Saint-Jean-sur-Richelieu, C.P. 457, Qc, J3B 6Z8.

Claude B. Aubé
Directeur

LÉGUMES

Évaluation de cultivars

Des essais de cultivars de légumes ont été réalisés en collaboration avec l'Association des manufacturiers de produits alimentaires du Québec. Des essais avancés ont été entrepris sur 18 cultivars de pois verts, 24 d'haricots verts et jaunes, 10 de maïs sucré, 8 de carottes et 4 de brocolis. Ces essais ont permis d'évaluer le potentiel de ces cultivars lorsqu'on leur fait subir le conditionnement pour la congélation ou les différents traitements de préparation avant la mise en conserve. Afin de répondre aux goûts des consommateurs, l'industrie se doit d'être à la fine pointe des recherches sur les possibilités offertes par les nouveaux cultivars de légumes produits par les grainetiers internationaux.

Élimination de l'herbicide Randox (Alidochlore)

Afin de répondre à l'inquiétude des producteurs d'oignons du Québec au sujet du retrait graduel du Randox (Alidochlore) comme herbicide de l'oignon, on effectue depuis 2 ans des essais variés afin de trouver un substitut à cet herbicide. Les essais répétés montrent que le traitement de l'oignon en pré–émergence avec du Ramrod (Propachlore) nous donnent les meilleurs résultats. Cependant, les recherches se poursuivent étant donné que le Ramrod n'est pas homologué au pays.

Rémanence de l'Ethion dans des radis cultivés en sol organique

Des radis cultivés en sol organique ont été traités avec de l'Ethion-Thiram 5g-7,5g, au semis. Au moment de la récolte, c'est-à-dire entre 20 et 30 jours après le semis, aucun résidu d'Ethion n'a été détecté par chromatographie en phase gazeuse et ce, jusqu'à la limite de 0,007 ppm. Ces résultats s'ajoutent au dossier en vue de son homologation pour emploi limité contre la mouche du chou *Delia radicum* (*Hylemya brassicae*).

Persistance et translocation du fonofos

Afin d'évaluer les effets de la concentration cuprique du sol sur l'insecticide Dyfonate^R (fonofos) utilisé pour protéger une culture d'oignons (*Allium cepa* «Autumn Spice») contre la mouche de l'oignon (*Delia radicum*), l'insecticide granulaire a été incorporé dans le sol des microparcelles à Sainte-Clotilde sur tourbe et sur sol humifère, lesquelles contenaient de 4 à 6 fois la quantité de cuivre nécessaire pour ralentir la décomposition et l'affaissement des sols organiques. Les analyses du sol au cours de la saison végétative démontrent que la persistance ainsi que la translocation dans l'oignon de l'insecticide fonofos n'est pas affecté par les niveaux de cuivre dans le sol organique. Sur tourbe, la concentration initiale du sol en cuivre était la plus basse et les deux fumures cupriques les plus riches ont amélioré le rendement. La concentration en cuivre de toutes les cultures était inférieure au seuil de phytotoxicité (20 ppm).

Lutte contre le nématode cécidogène

Dans des parcelles fortement infestées par le nématode cécidogène, *Meloidogyne hapla*, une année en culture d'épinard, d'oignon ou de radis a réduit à moins de 5% les pertes de rendement en culture de carotte l'année suivante. La jachère et les céréales comme l'avoine, le blé et l'orge ont également diminué les pertes de rendement causées par le *M. hapla*. Par contre, la tagète s'est avérée peu efficace, avec 35% de perte en carottes bonnes pour le marché. Cependant, la laitue, le céleri et le poireau ont permis un accroissement des populations du *M. hapla* et ont ainsi maintenu les pertes à plus de 50%.

Un semis hâtif au début de mai a permis d'augmenter de 48% les rendements de carottes dans un sol organique fortement infesté par le *M. hapla*. Une faible densité de semis a accentué la sévérité des dommages comparativement à un semis standard. Les deux cultivars Gold Pak et Spartan Premium ont démontré une forte sensibilité aux dommages causés par le nématode cécidogène.

Dynamique des polyphosphates en sol organique

Les études en serre et au champ tendent à démontrer que les polyphosphates liquides sont des sources de phosphates aussi efficaces que les phosphates habituels pour la production de légumes en sols organiques. En effet, les polyphosphates y sont rapidement dégradés en orthophosphates assimilables par les végétaux. Cette dégradation est assurée par des enzymes qui montrent une très bonne activité au pH optimal pour les cultures. L'activité enzymatique peut être ralentie par le chaulage et l'addition de cuivre. Le principal polyphosphate présent dans l'engrais, soit le pyrophosphate, a une demi-vie inférieure à une semaine dans les sols organiques étudiés au laboratoire. Une corrélation très significative existe entre la vitesse de dégradation du pyrophosphate et l'activité de l'enzyme dans le sol. Apparemment, l'activité enzymatique est maximale dans les sols vierges, mais elle demeure à un niveau suffisamment élevé en sol cultivé pour assurer l'efficacité des polyphosphates. Une méthode de laboratoire a été mise au point pour tester l'activité des pyrophosphatases en sol organique.

Résistance à la hernie

Des lignées de choux résistants aux races 2 et 6 du pathogène *Plasmodiophora brassicae* ont été obtenues par hybridation interspécifique entre le chou (*Brassica oleracea* spp. *capitata*) et le rutabaga (*B. napus*). Toutefois, la teneur en glucosinolates des plants résistants est plus élevée que celle des cultivars commerciaux. En 1982, on a entrepris un projet de recherche dans le but de sélectionner des choux résistants à la hernie et à faible teneur en glucosinolates. Après deux générations, plusieurs lignées ont été obtenues contenant peu de glucosinolates, en particulier des thiocyanates, et une absence totale de goitrine dans 4 lignées.

PETITS FRUITS

Le groseillier Selby

Le Selby, un groseillier (*Ribes grossularia*) presque sans épines à l'essai sous le numéro 581204 a été nommé en 1983. Quoique son origine soit inconnue, il est fort possible qu'il dérive du Spinefree et du Captivator, deux cultivars sans épine auprès desquels il a été testé. La croissance vigoureuse et dressée des tiges et la forme des buissons en rendrait possible la cueillette mécanisée. Le feuillage et les fruits sont légèrement sensibles au blanc (*Sphaerotheca mors-uvae* Schw. Berk. & Curt.), mais il est facile de garder la maladie en échec par des traitements fongiques habituels. La productivité du Selby se compare à celle des autres cultivars commerciaux. Par contre, la grosseur de ses fruits et l'absence presque complète d'épines en font un cultivar supérieur au Captivator et au Pixwell, deux des plus utilisés au Québec.

ARBRES FRUITIERS

Amélioration du pommier

Deux nouveaux cultivars de pommiers résistants à la tavelure causée par le *Venturia inaequalis* ont été nommés en 1983. Le Rouville et le Richelieu ont été observés et évalués depuis 1974 et sont demeurés exempts de tavelure sans l'aide de traitement fongicide.

Le Rouville et le Richelieu ont été sélectionnés en 1972 par H.B. Heeney, à la ferme expérimentale de Smithfield, Agriculture Canada, Trenton, (Ont.), à la suite de croisements réalisés en 1962 et 1964 sous la direction de L.P.S. Spangelo, station de recherches, Agriculture Canada, Ottawa, (Ont.).

Ces deux cultivars sont précoces et productifs. Tous deux produisent des fruits d'un calibre supérieur à 65 mm dont le jus satisfait à plusieurs exigences de l'industrie de la transformation. De plus, la qualité gustative des fruits est acceptable.

Par ailleurs, la technique de multiplication *in vitro* permet de cloner le porte-greffe du pommier Ottawa 3. Des méthodes ont en effet été mises au point pour obtenir des cultures de pousses normales et pour la prolifération et l'enracinement rapide *in vitro* du porte-greffe du pommier Ottawa 3, à partir de méristèmes apicaux. Grâce à ces méthodes, le porte-greffe du pommier Ottawa 3, rustique et nanisant, devrait être plus facilement disponible pour répondre à la demande croissante de l'industrie pour ce type de porte-greffe.

CHIMIE ET SOL

L'évolution d'un sol organique nouvellement mis en valeur

Trois études de drainage ont été effectuées sur un sol organique en développement où on a superposé trois méthodes culturales. On a mesuré les rendements de carottes, l'affaissement du sol, la fluctuation de la nappe d'eau, la performance des drains souterrains, la conductivité hydraulique et la densité apparente du sol. Les rendements de carottes ont été plus élevés lorqu'on a utilisé la bêche rotative plutôt que le discage ou le labour durant la première année. Après 7 ans, l'affaissement totalisait 515 mm et dépendait en grande partie de la profondeur du sol. La conductivité hydraulique n'a pas changé après 5 ans de drainage. La densité apparente de la couche du sol de 0,0 à 0,2 m a augmenté de 71% en 6 ans, tandis que dans le profil, les augmentations ont varié de 3,3 à 16,2%.

On a étudié, dans des contenants de sol organique non perturbé en serre, l'effet de deux profondeurs de nappe d'eau (PNE), soit 0,6 et 0,9 m, sur la tension d'humidité, l'affaissement, le gonflement du sol et les rendements de carottes. Ceux-ci ont été abaissés par la PNE de 0,9 m. Dans la PNE de 0,9 m, l'affaissement a été deux fois plus élevé que dans la PNE de 0,6 m. Une remontée de la nappe d'eau près de la surface a fait gonfler le sol.

On a mesuré la conductivité hydraulique, la densité apparente, le pourcentage de fibres et la porosité drainable dans des monolithes de sol organique. Les valeurs de ces quatre propriétés ont diminué proportionnellement à la profondeur des profils.

AUTRES

Étude sur l'utilisation des sous-produits de l'élevage du vison au Québec

À l'aide d'un contrat de recherches, on a produit, à des coûts très bas, une qualité d'huile de vison supérieure à celle qui est mise actuellement sur le marché et une graisse avec laquelle nous pourrions fabriquer des produits de beauté comme des pains de savon, des crèmes, etc.

Fines herbes

Des essais culturaux ont été effectués en sol minéral et en sol organique afin d'évaluer le potentiel de production du cerfeuil (*Anthriscus cerefolium*), de la marjolaine (*Origanum vulgare*), de la sauge (*Salvia officinalis*), de la valériane (*Valeriane officinalis*) et de la monarde (*Monarda fistulosa*). Il appert que le sol organique est beaucoup plus favorable au développement des différentes espèces à l'essai que le sol minéral. En effet, on a récolté de 3 à 10 fois plus de matière brute à Sainte-Clotilde qu'à L'Acadie. Même si les concentrations en huiles essentielles et en substances actives étaient un peu plus faibles en sol organique, il n'en demeure pas moins que ce dernier type de sol semble plus avantageux.

TABAC

Production

Stade d'écimage et densité de plantation. La qualité des cultivars Delhi 34 et Delhi 76 a été améliorée quand ils ont été écimés au stade début bouton; par ailleurs, leur production a été plus élevée par un écimage au stade bouton. À un espacement de 61 cm entre les plants, la qualité de la récolte du Delhi 76 a été meilleure qu'à des distances moindres, alors que la qualité de la récolte du Delhi 34 a été favorisée par un espacement de 51 cm. Cependant, le rendement des deux cultivars a été plus élevé avec un espacement de 41 cm. En général, les écarts entre les paramètres étudiés ont été minces; il n'y a donc pas lieu de modifier les pratiques culturales courantes, du moins pour ces deux cultivars de tabac jaune.

Effet de la fertilisation sur la composition chimique du tabac jaune. Durant 3 ans, on a étudié l'effet d'une fumure N, P, K sur la composition chimique de la récolte du tabac. Le canevas expérimental comprenait quatre niveaux de chacun des éléments fertilisants évalués sur deux types de sol, soit un loam sableux Soulanges et un sable Uplands.

L'azote et le potassium sont les éléments qui ont eu la plus grande influence sur les paramètres étudiés et sur les deux types de sol. La fumure azotée a favorisé l'accroissement de la teneur en nicotine, en alcaloïdes totaux et en azote total, mais a entraîné une diminution du taux de sucres réducteurs. À l'opposé, les apports de phosphore et de potassium ont fait baisser la teneur en nicotine, en alcaloides totaux et en azote total et ont favorisé un accroissement des sucres réducteurs.

Régie du tabac à cigare. Au cours d'une expérience d'une durée de 3 ans, les variations des caractéristiques agronomiques, morphologiques et de la composition chimique ont été étudiées en relation avec l'espacement des plants, le stade et la hauteur d'écimage. Un espacement de 30 cm entre les plants et un écimage au stade 50% floraison ont favorisé le meilleur rendement et le meilleur revenu brut, ainsi qu'une teneur plus élevée en nicotine et en alcaloides totaux. Cette pratique culturale a également eu une incidence positive sur l'indice de la surface foliaire.

Physiologie

Tabac gris. Quatre niveaux de chaux et de fumier de bovin ont été appliqués, en combinaison factorielle, sur un sol avec antécédent de tabac gris, par comparaison avec une fumure témoin faite de 2 — 12 — 16 T. Au moment de la récolte, aucune des parcelles, indépendamment des traitements, n'avait manifesté des symptômes visibles.

Sur sable grossier, les pluies abondantes lessivent les éléments nutritifs, réduisent chimiquement le Fe et d'autres cations et, semble-t-il, ces effets sont indispensables au développement de l'aspect cuivré et poivré caractéristique des feuilles vertes de tabac gris. Les précipitations au cours des mois de juin, juillet et août n'ont été respectivement que de 48, 64 et 55% des précipitations normales, ce qui expliquerait l'absence de tabac gris et, par le fait même, confirmerait la relation entre le lessivage des éléments nutritifs par la pluie et le développement du tabac gris au champ. Cet essai a démontré l'importance de la matière organique fournie par le fumier et qui a eu pour effet d'accroître significativement l'indice de qualité et le rendement.

HORTICULTURE ORNEMENTALE

Étude de milieux d'enracinement des boutures

Concentrations hormonales. Parmi les neuf espèces de plantes ornementales soumises à des traitements hormonaux en vue d'amorcer l'enracinement des boutures, cinq espèces ont réagi de façon significativement supérieure ($P = 0,05$) par rapport au témoin non traité aux hormones. À des concentrations variant de 5 000 à 40 000 ppm d'acide indole butyrique (AIB) et d'acide naphtalène acétique (ANA), le *Cotoneaster acutifolius* s'est enraciné significativement mieux que le témoin. Pour le *Philadelphus delavavi*, les traitements AIB 5 000 ppm et ANA 20 000 ppm ont été significativement supérieurs. Le *Prunus tomentosa* a été favorisé par le traitement AIB 5 000 et 10 000 ppm et le traitement ANA 5 000, 10 000 et 20 000 ppm. Seul le traitement AIB 5 000 ppm été requis pour l'enracinement du *Symphoricarpos alba-laevigatus*, alors que les taux de AIB 5 000, 10 000 et 20 000 ppm ont été les plus efficaces pour le *Lonicera stanantha* Les divers traitements hormonaux ont été sans effet sur la rhizogénèse du *Cornus amomum*, du *Eleagnus angustifolia*, du *Lonicera involucrata* et du *Ribes missouriense*.

Le Sylvagrest. Constitué d'agrestats stabilisés appelés lignocellulosiques, et produits à Pouxeux, France, le Sylvagrest semble offrir un potentiel comme substitut aux substrats commerciaux utilisés pour la rhizogénèse de boutures de différentes espèces de plantes ornementales. Utilisé seul ou en mélange avec des produits commerciaux, ce nouveau produit n'a pas été supérieur à ses concurrents pour l'enracinement de plants des genres *Betula*, *Physocarpus*, *Cotoneaster* et *Prunus*.

MAÏS GRAIN

Amélioration

Provenant du second composite (B) de Saint--Jean, quatre lignées autofécondées ont été identifiées en regard de leur bonne aptitude générale à la combinaison pour le rendement et la résistance à la pyrale, l'*Ostrinia nubilalis*, de leur précocité, du calibre de l'épi et de leur bonne autofécondation et formation du grain. Au total, 46 lignées du troisième composite (C) ont été autofécondées et utilisées en «test-cross» pour vérifier leur aptitude générale à la combinaison. De plus, quatre nouveaux composites résistants à la pyrale ont progressé d'une génération par croisement non sélectif.

Les seize lignées et populations hâtives sélectionnées pour leur précocité et leurs attributs agronomiques ont manifesté une bonne résistance à la pyrale; parmi celles-ci, des sélections seront utilisées en vue de développer de nouveaux composites précoces et résistants à la pyrale.

PUBLICATIONS

Recherche

Batra, T.R.; McAllister, A.J.; Chesnais, J.P.; Darisse, F.P.F.; Emsely, J.A.B.; Lee, A.J.; Roy, G.L.; Vesely, J.A. et Winter, K.A. 1983. Comparison of the heifer reproduction traits of the daughters of several sire groups. Can. J. Anim. Sci. 63:269-278.

Binns, M.; Ogilvie, I.S.; Arnold, N.; Lukosevicius, P. 1983. Size of plots and blocks in agricultural experiments: an empirical study with cigarfiller tobacco. Indian J. Agric. Sci. 53:706-712.

Boivin, G. 1983. Seasonal development and interplant movements of phytophagous mirids (Hemiptera: Miridae) on alternate host plants in and around an apple orchard. Ann. Entomol. Soc. Am. 76:776-780.

Boivin, G.; Stewart, R.K. 1983. Distribution of phytophagous mirids (Hemiptera: Miridae) on apple trees in relation to habitat availability. Environ. Entomol. 12:1641-1645.

Boivin, G.; Stewart, R.K. 1983. Spatial dispersion of phytophagous mirids (Hemiptera: Miridae) of apple trees. J. Econ. Entomol. 76:1242-1247.

Boivin, G. 1983. Bibliography of the pear plant bug *Lygocoris communis* (Knight) (Hemiptera: Miridae). Biblio. Entomol. Soc. Am. no. 2, p. 1-9.

Boivin, G.; Stewart, R.K. 1983. Sampling technique and seasonal development of phytophagous mirids (Hemiptera: Miridae) on apple in Southwestern-Quebec. Ann. Entomol. Soc. Am. 76:359-364.

Bostanian, N.J.; Boivin, G.; Goulet, H. 1983. The ramp pitfall trap. J. Econ. Entomol. 76:1473-1475.

Chiang, M.S. 1983. Inheritance of 'clustered flowers' in cabbage. J. Heredity, 74:116.

Chiang, M.S. Crête, R. 1983. Transfer of resistance to race 2 of *Plasmodiophora brassicae* from *Brassica napus* to cabbage (*B. oleracea* spp. *capitata*). V. The inheritance of resistance. Euphytica, 32:479-483.

Chong, C.; Bérard, L.S. 1983. Changes in glucosinolates during refrigerated storage of cabbage. J. Am. Soc. Hort. Sci. 108:688-691.

Dominique, C.R.; Yule, W.N.; Martel, P. 1983. Influence of soil type, soil moisture, and soil surface conditions on oviposition preference of the Northern Corn Rootworm, *Diabrotica longicornis*. Can. Entomol. 115:1043-1046.

Granger, R.L.; Looney, N.E. 1983. Radio-calcium uptake by 'Spartan' and 'Delicious' apple as influenced by rootstock and BA + GA_3 to activate growth of lateral buds. HortSci. 18:314-316.

Granger, R.L.; Plenchette, C.; Fortin, J.A. 1983. Effect of a vesicular arbuscular (VA) endomycorrhizal fungus (*Glomus epigaeus*) on the growth and leaf mineral content of two apple clones propagated *in vitro*. Can. J. Plant Sci. 63:551-555.

Lamarre, M. 1983. Influence des méthodes culturales sur les données agronomiques et chimiques du cultivar de tabac à cigarette Delhi 76. Can. J. Plant Sci. 63:337-339.

Lamarre, M. 1983. Influence de la fertilisation N, P et K sur la composition chimique du tabac à cigarette. Can. J. Plant Sci. 63:523-529.

Lamarre, M. 1983. Réponse du tabac à cigare aux différentes méthodes culturales. Can. J. Plant Sci. 63:1047-1052.

Lana, A.F.; Peterson, J.F.; Rousselle G.L.; Vrain, T.C. 1983. Association of tobacco ringspot virus with a union incompatibility of apple. Phytopathol. Z. 106:141-148.

Mathur, S.P.; Bélanger, A.; Valk, M.; Preston, C.M.; Knibe, E.; Sanderson, R.B. 1983. A study of onions grown in microplots of three organic soils each containing four levels of copper. Can. J. Soil Sci. 63:221-228.

Millette, J.A. 1983. Effect of water table depths on the growth of carrots and onions on an organic soil *in vitro*. Can. J. Plant Sci. 63:739-746.

Ogilvie, I.S.; Kozumplik, V. 1983. Genetic analysis of quantitative characters in cigar and pipe tobacco, *Nicotiana tabacum*. III. Grades of cigar filler tobacco. Can. J. Genet. Cytol. 25:185-189.

Parent, L.E.; Perron, Y. 1983. L'adsorption du cuivre par trois types de tourbe. Nat. Can. 110:67-70.

Pua, E.C.; Chong, C.; Rousselle, G.L. 1983. *In vitro* propagation of Ottawa 3 apple rootstock. Can. J. Plant Sci. 63:183-188.

Vigier, B.; Raghavan, G.S.V.; Drake, G. 1983. Effect of soil compaction and sterilization on root rot disease and canning peas yield. Can. J. Plant Sci. 63:327-331.

Divers

Boivin, G.; Vincent, C. 1983. Sequential sampling for pest control programs. Agr. Can., Bull. tech. 14E, 29 p.

Boivin, G.; Vincent, C. 1983. L'échantillonnage séquentiel en phytoprotection, revue de la méthode. Agr. Can., Bull. tech., 14F.

Granger, R.L.; Rousselle G.L.; Lalonde. D. 1983. Plantation de la pommeraie. Guide de Production du Pommier 1983. MAPAQ, Agdex 211/20, p. 15-20.

Granger, R.L.; Rousselle, G.L.; Lalonde D.; Charbonneau, R. 1983. Plantation de la pommeraie, *in* Pommier, culture. MAPAQ, Agdex 211/20, p. 15-19.

Granger, R.L.; Rousselle, G.L. 1983. Formation du pommier, in Pommier, culture. MAPAQ, Agdex 211/20, p. 24-33.

Lamarre, M. 1983. Study of the chemical composition of tobacco and tobacco soils in Quebec. The Lighter 53:9-14.

Lamarre, M. 1983. Enquête sur la composition chimique du tabac et des sols à tabac au Québec. Le Briquet 53:9-14.

Lamarre, M. 1983. Fertilisation et régie des sols. Guide du tabac jaune. MAPAQ, Agdex 1981/20.

Philion, P.; Granger, R.L. 1983. Régulateurs de croissance. Guide de production du pommier 1983. MAPAQ, Agdex 211/20, p. 44-47.

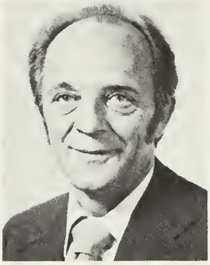
Richer-Leclerc, C.; Chong, C. 1983. The effects of willow extract on rooting of ornamental species. Can. Agr. 28:33-35.

Richer-Leclerc, C.; Chong. C. 1983. L'influence des extraits de saule sur l'enracinement d'espèces ornementales. Can. Agr. 28:33-36.

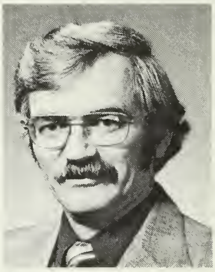
Rousselle, G. . 1983. Porte-greffes. *in* Pommier, culture. MAPAQ, Agdex 211/20, p. 12-15.

ONTARIO REGION
RÉGION DE L'ONTARIO

Dr. J. J. Cartier



Dr. H. Baenziger



Mr. D. G. Proctor

EXECUTIVE OF THE ONTARIO REGION
L'EXÉCUTIF DE LA RÉGION DE L'ONTARIO

Director General
Directeur général

J. J. Cartier, B.A., B.Sc., Ph.D.

Program Specialist
Spécialiste en programmes

H. Baenziger, Ing. Agr., M.Sc., Ph.D.

Acting Chief, Administration
Chef intérimaire, administration

D. G. Proctor

PREFACE

The Ontario Region includes nine research establishments, namely the research stations at Ottawa, Vineland, Delhi, and Harrow, the London and the Animal research centres, and the experimental farms at Thunder Bay, Kapuskasing, and Smithfield. The regional headquarters is located in Ottawa. The total staff numbers about 870, of which about 175 are professionals. The total regional budget is in the area of $35–40 million.

The Animal Research Centre at Ottawa conducts research in nutrition, physiology, management, breeding, product quality, disease resistance, and genetics in beef and dairy cattle, swine, poultry, and sheep; animal waste management; and food safety and nutrition. Increased emphasis is placed on the introduction of the most up-to-date biotechnology methods to animal research. They focus on genetic manipulation of rumen bacteria and on embryo manipulation. Mycotoxin research over the past few years provided sound guidelines on contamination tolerance in feeds.

At the Ottawa Research Station plant breeding programs are conducted in cereals, forages, soybeans, and some ornamentals. From these programs new cultivars or hybrids with improved disease resistance, yield, quality, and maturity have been produced, for example Leger barley and Maple Arrow soybean. In forage legumes the capability for nitrogen fixation in alfalfa and red clover is also being improved. In ornamentals numerous flowering shrubs, particularly roses, with better adaptation to our harsh climate have been introduced. All breeding programs are supported with research in pathology, physiology, entomology, cytogenetics, and grain quality. A biotechnology center of excellence is being developed according to plan, and some practical results are emerging from this program. The Kapuskasing Experimental Farm functions in cooperation with the Ottawa Research Station on crop research and in cooperation with the Animal Research Centre on beef production research. Improved beef production systems based on adapted, locally produced feeds (forages, small grains) are being developed. The Thunder Bay Experimental Farm evaluates adaptation of forage, grain, and horticultural crops to the area.

Research at the Vineland Research Station focuses on integrated pest management for orchard and vegetable crops, grapes, ornamentals, and some forage crops. The station also provides some research support in pest control for mushroom production. The aim of these programs is to reduce the use of chemical pesticides while maintaining crop productivity and produce quality. The station also maintains a virus-free nuclear stock repository of strawberries, raspberries, and tree fruits. The Smithfield Experimental Farm program includes plant breeding research in apples and tomatoes and crop management work in orchard and vegetable crops. Pest monitoring in orchards is carried out as an integral part of the integrated pest management approach. In support of local industries Smithfield also features some produce-processing research.

The Delhi Research Station is the center for research on flue-cured tobacco in Canada and it provides support to the industry in Ontario, Quebec, and the Maritimes. The improved cultivars and production technologies being developed are being implemented by the growers. Over the past few years the use of improved Delhi cultivars in Ontario has increased from about 50% to well over 90%. In 1983 the Station celebrated its 50th anniversary.

The London Research Centre concentrates on research in integrated pest management, as well as on environmental quality research. The management of insect, disease, and weed pests is investigated with a view to reducing the reliance of the agri-food industry on chemical pesticides. Research involves the study of biological pest control methods as well as the search for new, environmentally safer control strategies.

The Harrow Research Station serves the climatically most-favored area of Ontario. Southwestern Ontario produces a great variety of crops and consequently Harrow has the most diverse research program in the Region. Research is being conducted on field crops such as corn, soybeans, winter wheat, field beans, and burley tobacco and on several tree fruit and vegetable species. The aims of these programs are to develop improved cultivars and superior production technologies. The development of efficient integrated pest management techniques is a high priority. The Harrow Research Station also provides research support to producers of greenhouse crops such as cucumbers, tomatoes, and ornamentals.

Detailed information on the various programs may be obtained by writing to the establishments concerned or by addressing inquiries to Ontario Region Headquarters, Research Branch, Agriculture Canada, Central Experimental Farm, Ottawa, Ont. K1A 0C6.

J. J. Cartier

PRÉFACE

La Région de l'Ontario comprend neuf établissements de recherches, soit les stations d'Ottawa, Vineland, Delhi et Harrow, le Centre de London et le Centre de recherches zootechniques, ainsi que les fermes expérimentales de Thunder Bay, Kapuskasing et Smithfield. Le siège administratif régional est à Ottawa. Le personnel compte environ 870 membres dont quelque 175 professionnels. Le budget régional global est de l'ordre de 35 à 40 millions de dollars.

Le Centre de recherches zootechniques à Ottawa s'adonne à des recherches sur la nutrition, la physiologie, l'élevage, la sélection, la qualité des produits, la résistance aux maladies, la génétique des bovins laitiers et de boucherie, des porcs, des volailles et des moutons; sur l'utilisation des fumiers, et sur la valeur nutritive et la salubrité des aliments. On met l'accent sur des procédés biotechniques les plus récents dans la recherche zootechnique. Les recherches se portent en particulier sur les manipulations génétiques des bactéries de la panse et des embryons. Les études sur les mycotoxines de ces dernières années ont fourni de bonnes indications concernant la tolérance à la contamination des aliments du bétail.

À la station de recherches d'Ottawa, les programmes en cours sur la sélection des plantes portent sur les céréales, les plantes fourragères, le soja et quelques plantes ornementales. Ces programmes produisent de façon continue de nouveaux cultivars ou hybrides plus résistants aux maladies et d'un rendement, d'une maturité et d'une qualité supérieurs, comme l'orge Léger et le soja Maple Arrow. En ce qui concerne les plantes ornementales, on a obtenu de nombreuses espèces florales buissonnantes, en particulier des rosiers, mieux adaptées aux rigueurs de notre climat. Ces programmes de sélection sont appuyés par des recherches en pathologie, physiologie, entomologie, cytogénétique et sur la qualité des grains. Le Centre d'excellence biotechnologique se développe selon les prévisions et divers résultats pratiques de ce programme sont déjà apparents. La ferme expérimentale de Kapuskasing travaille conjointement avec la station de recherches d'Ottawa à des recherches sur les plantes cultivées, ainsi qu'avec le Centre de recherches zootechniques pour ce qui est de la production des bovins de boucherie. On y perfectionne les méthodes utilisées pour la production de ce genre de bétail en recourant à des aliments adaptés aux conditions locales (fourrages et grains de provende). La ferme expérimentale de Thunder Bay évalue les conditions d'adaptation de certaines cultures fourragères, céréalières et maraîchères au milieu régional.

À la station de Vineland, la recherche poursuit surtout un plan coordonné de lutte contre les parasites ayant pour objets les vergers et les cultures maraîchères, vignes, plantes ornementales et diverses cultures fourragères. La station concourt également dans une certaine mesure à la lutte aux parasites des champignonnières. Ces programmes ont pour but de réduire le recours aux antiparasitaires chimiques tout en préservant la productivité des récoltes et la qualité des produits. La station détient également une réserve de matériel-souche de fraises, de framboises et de gros fruits exempts de virus. La ferme expérimentale de Smithfield inclut dans son programme des recherches sur la sélection des pommes et des tomates, et elle s'occupe également de l'exploitation des vergers et des plantes maraîchères. La surveillance des parasites des vergers s'effectue dans le cadre de la lutte intégrée contre les ennemis des récoltes. Comme aide aux industries locales, Smithfield effectue également certaines recherches sur la transformation des produits agricoles.

La station de Delhi est le centre de recherche du Canada sur le tabac séché artificiellement et ses services s'étendent à l'industrie du tabac de l'Ontario, du Québec et des Maritimes. On y met au point des cultivars nouveaux et de meilleures techniques de production que l'on propose ensuite aux producteurs. Durant les dernières années, l'utilisation des cultivars améliorés de Delhi, en Ontario, est passé d'environ 50 % à plus de 90 %. La station a célébré en 1983 son cinquantième anniversaire.

Le Centre de recherches de London concentre ses travaux sur la lutte intégrée contre les ennemis des récoltes ainsi que sur la qualité de l'environnement. Les études concernant les agents ravageurs: insectes, maladies et mauvaises herbes ont pour but de réduire la dépendance des agriculteurs à l'égard des pesticides chimiques. La recherche s'attache donc à des procédés biologiques de lutte contre les parasites ainsi qu'à l'obtention de stratégies nouvelles qui amélioreront la sécurité de l'environnement.

La station de Harrow dessert la région de l'Ontario la plus favorisée par le climat. Le sud-ouest de la province produit une grande variété de récoltes, ce qui a fait de cette station la plus diversifiée de la région par son éventail de recherches. Celles-ci s'adressent aux principales grandes cultures, telles le maïs, le soja, le blé d'hiver, les haricots et le tabac burley et sur plusieurs espèces d'arbres fruitiers et de légumes. Le but des programmes est de produire des cultivars améliorés et de perfectionner les techniques de production. L'élaboration de techniques coordonnées efficaces contre les ennemis des récoltes y occupe un rang privilégié. La station de recherches de Harrow apporte également son aide aux producteurs de cultures en serres, telles que concombres, tomates et plantes ornementales.

Les personnes intéressées peuvent recevoir des renseignements plus détaillés sur les divers programmes en écrivant aux établissements concernés ou en adressant une demande au siège de la Région de l'Ontario, Direction générale de la recherche, Agriculture Canada, Ferme expérimentale centrale, Ottawa (Ont.) K1A 0C6.

J.J. Cartier

Animal Research Centre
Ottawa, Ontario

PROFESSIONAL STAFF

Administration

R. S. Gowe, B.S.A., M.S., Ph.D.	Director
S. Mahadevan,[1] B.Sc., M.Sc., Ph.D.	Acting Deputy Director
J. I. Elliot,[2] B.S.A., M.Sc., Ph.D.	Acting Deputy Director
D. A. Leger, B.Sc.	Assistant to the Director
J. R. Harrison, B.Sc.	Administrative Officer, Finance
G. R. Ford[3]	Administrative Officer, Personnel

Scientific Support

K. G. Hilson,[4] B.Sc., M.Sc.	Project Manager; Computer services
D. L. Brewin[4]	Programmer/Analyst
B. J. McKelvey	Programmer/Analyst
H. M. Mucha	Programmer/Analyst
G. I. Smith, B.Math.	Programmer/Analyst
K. E. Hartin, D.V.M.	Veterinarian

Animal Waste Utilization

N. K. Patni, B.Ch.E., M.Sc., Ph.D.	Program Chairman; Livestock waste utilization, farm pollution abatement

Trace Mineral and Beef Cattle Nutrition

M. Hidiroglou, D.V.M., Dip.Nutr.	Program Chairman; Vitamin D nutrition
M. Ivan, Ing., M.Sc., Ph.D.	Nutrition and metabolism of trace minerals
D. M. Veira, B.Sc., M.Sc., Ph.D.	Ruminant nutrition

Dairy Cattle Breeding and Production

A. J. McAllister, B.S., M.S., Ph.D.	Program Chairman; Dairy cattle breeding and production—applied quantitative genetics
T. R. Batra, B.V.Sc., M.V.Sc., Ph.D.	Dairy cattle breeding—applied quantitative genetics
A. J. Hackett, D.V.M., M.Sc., Ph.D.	Female reproductive physiology
A. J. Lee, B.Sc. (Agr.), Ph.D.	Dairy cattle breeding and production—applied quantitative genetics
C. Y. Lin, B.S., M.S., Ph.D.	Dairy cattle breeding—applied quantitative genetics
G. J. Marcus, B.A., Ph.D.	Maternal–embryonic physiological interactions
J. Nagai,[5] B.Sc., D.Agr.	Quantitative genetics—mice

Dairy Cattle Nutrition

F. D. Sauer, D.V.M., M.S., Ph.D.	Program Chairman; Rumen metabolism and nutrition
A. S. Atwal, B.Sc. (Agr.), M.Sc., Ph.D.	Forage evaluation and nutrition
J. D. Erfle, B.S.A., M.Sc., Ph.D.	Rumen metabolism and nutrition
K. J. Jenkins, B.S.A., M.Sc., Ph.D.	Calf nutrition
J. R. Lessard,[6] B.A., B.S.A., M.S., Ph.D.	Forage conservation and nutrition
S. Mahadevan,[1] B.Sc., M.Sc., Ph.D.	Rumen physiology and ruminant nutrition
R. M. Teather, B.Sc., Ph.D.	Rumen microbiology

Swine Production

D. W. Friend, B.Sc., M.Sc., Ph.D.	Program Chairman; Sow and piglet nutrition
J. I. Elliot,[2] B.S.A., M.Sc., Ph.D.	Sow nutrition, artificial rearing
A. Fortin,[7] B.Sc. (Agr.), Ph.D.	Carcass evaluation—swine, poultry, sheep, cattle
D. G. Fraser, B.A., Ph.D.	Animal behavior—swine, sheep, cattle
N. K. Sarkar, B.Sc., M.Sc., D.Sc.	Protein biochemistry

Poultry Breeding

J. S. Gavora, Ing., C.Sc.	Program Chairman; Disease resistance genetics, egg stock breeding and management, broiler breeding
D. E. Bernon, B.Sc. (Agr.), M.Sc., Ph.D.	Quantitative genetics—meat animals
J. R. Chambers, B.Sc., M.Sc., Ph.D.	Broiler breeding and management

R. W. Fairfull, B.Sc., M.Sc., Ph.D.	Egg stock breeding and management
R. S. Gowe, B.S.A., M.S., Ph.D.	Egg stock breeding and management
A. A. Grunder, B.S.A., M.Sc., Ph.D.	Eggshell quality genetics, broiler breeding, goose breeding and management
C. P. W. Tsang, B.Sc., M.Sc., Ph.D.	Genetics and physiology—eggshell quality and egg production

Poultry Nutrition

R. M. G. Hamilton, B.Sc. (Agr.), M.Sc., Ph.D.	Program Chairman; Nutrition and physiology, eggshell quality, mycotoxins
N. A. G. Cave, B.Sc., M.Sc., Ph.D.	Amino acids and proteins, broiler breeder nutrition and management
I. R. Sibbald, B.Sc. (Agr.), M.Sc., Ph.D., D.Sc.	Avian energetics and feedingstuff evaluation

Sheep Production

L. Ainsworth, B.Sc., M.Sc., Ph.D.	Program Chairman; Female reproductive physiology
P. S. Fiser, B.Sc., M.Sc., Ph.D.	Male reproductive physiology
D. P. Heaney, B.S., M.S., Ph.D.	Nutrition and intensive management
G. A. Langford, B.Sc., M.Sc., Ph.D.	Male reproductive physiology
J. N. B. Shrestha, B.V.Sc.A.H., M.S., Ph.D.	Breeding and intensive production—applied quantitative genetics

Animal Feed Safety and Nutrition

H. L. Trenholm, B.Sc., Ph.D.	Program Chairman; Mycotoxins, toxicology
M. H. Akhtar, B.Sc., M.Sc., Ph.D.	Pesticide metabolism and residues
L. M. Coté,[8] B.Sc., M.Sc.	Biochemical toxicology, mycotoxins
E. R. Farnworth, B.Sc., M.Sc., Ph.D.	Lipid nutrition and metabolism
J. K. G. Kramer, B.Sc., M.Sc., Ph.D.	Lipid chemistry and biochemistry
D. B. Prelusky,[9] B.Sc., Ph.D.	Mycotoxin metabolism

Departures

D. L. Blakley, B.A.	Chief, Administration and Resources

Transferred to Department of National Defense, 19 August 1983

K. G. Hollands, B.A., B.S.A., M.S.A. Deceased 15 February 1983	Disease resistance and eggshell quality genetics
L. J. McDonald,[4] B.A., L.L.B. Resigned 9 September 1983	Programmer/Analyst
H. A. Robertson, B.Sc., Ph.D., C.Chem., F.R.I.C., F.R.S.E., F.I.Biol. Resigned 30 September 1983	Swine reproductive physiology
S. C. Thompson,[10] B.Sc., M.A., Ph.D. Transferred to Pacific Region Headquarters, 15 August 1983	Deputy Director
S. P. Yanosik[11] Transferred to Regina Research Station, 3 June 1983	Library Technician

VISITING SCIENTISTS

Natural Sciences and Engineering Research Council postdoctorate fellows

M. K. Akbar, B.Sc., M.Sc., Ph.D. 1981–1983	Poultry breeding
C. A. Kelleher, B.Sc., Ph.D. 1983–1984	Mineral metabolism
T. Tennessen, B.A., B.Sc., M.Sc., Ph.D. 1983–1984	Swine production

Graduate students

D. A. Flores, B.Sc.	Ruminant digestion
F. Levine, M.Sc.	Reproductive physiology
J. C. Segura, C.Ing.	Poultry genetics

---

[1] Acting Deputy Director, 28 June 1982–31 January 1983.

[2] On French language training, 4 October 1982–30 May 1983. Acting Deputy Director from 12 July 1983.

[3] Acting Chief, Administration and Resources, from 22 August 1983.

[4] Seconded from Systems and Consulting Division, Finance and Administration Branch.

[5] On transfer of work at Tohoku University, Sendai City, Japan, 11 April 1983–13 February 1984.

[6] Seconded to Research Branch, Program Coordination Directorate, 1 January 1983–31 December 1983.

[7] On transfer of work at Meat Research Institute, Agriculture Research Council, Langford, Bristol, England, 17 October 1983–30 September 1984.

[8] On education leave at the University of Illinois, Urbana, IL, from 21 May 1982 for an indefinite period.

[9] Appointed 6 September 1983.

August 1983.

[11] Seconded from Libraries Division, Finance and Administration Branch.

INTRODUCTION

The Animal Research Centre (ARC) is the main Canadian location for breeding and genetics research with dairy cattle, sheep, and poultry; it also has major research programs in the nutrition of dairy and beef cattle, sheep, swine, and poultry. ARC has research under way in animal waste utilization and management, reproductive physiology, trace mineral requirements, animal behavior, carcass evaluation, ruminant digestive physiology, and pesticides and other contaminants in animal feeds. The nine research program teams are multidisciplinary and are composed of scientists with a broad range of scientific knowledge. Both applied research and basic research that is directly related to the solution of the problem are carried out by these teams.

The major research effort is in studying the problems of farm livestock and poultry under intensive housing and management. Scientists of several disciplines, in particular genetics, nutrition, animal behavior, and reproductive physiology, are involved in both multidisciplinary and single-discipline studies to resolve the numerous problems associated with improving the productivity of intensively housed livestock and poultry.

In 1983, considerable emphasis continued to be placed on research on feedstuff contaminants, in response to the identified high-priority needs in this area. A new research position was added to the existing team of nutritionists, toxicologists, and biochemists from the swine, poultry, and dairy cattle programs who are conducting in-depth studies on the effects of consumption of various mycotoxins by livestock and poultry.

This annual report highlights research progress in 1983. The following advances are particularly noteworthy: it has been found that bulls are more efficient producers of good-quality meat than steers; the suckling ruminant can easily be supplied with supplemental vitamin D through mammary transfer; bovine cystic ovarian disease is independent of genetic origin or milk production level; in the national cattle breeding experiment, the Norwegian Red breed shows lifetime yields comparable to those of North American Holsteins; steam treatment of soybean meal effectively reduces degradation in the rumen; a synthetic gene has been constructed to alter the amino acid composition of rumen bacterial protein to improve its nutritional value; studies with calves have defined their ability to utilize fat peroxides and cheap fat sources in milk replacers; boar carcasses compare favorably with those of barrows in meat quality; green muscle disease can be detected by a biochemical test which can be used as a selection tool to decrease lesion incidence; further progress has been made in direct and indirect selection for disease resistance in poultry and determination of its effects on production; a new variety of naked oats has good potential for use in poultry diets; the usefulness of formalin in lamb milk replacers has been demonstrated and a new method developed for assessing movement and fertilizing capability of ram sperm.

The transfer of these research results from the laboratory to the farmers who can use them remains a high priority. Efforts in this regard were exemplified by the quantity of high-quality research data which are published in over 80 scientific papers and in more than 70 technical articles and items in the popular press. In 1983, a bulletin was published entitled *The TME system of feed evaluation*; it is a comprehensive summary of the system that uses true metabolizable energy for assessing feedingstuffs. The system has been adopted world wide and the precision feeding technique is also internationally recognized. Major multinational feedingstuff companies and smaller local businesses are now using the TME system.

The 5-day International Plowing Match was held in the Ottawa area during October and the ARC mounted a major exhibit. Among over 200 visitors to the Research Farm, ministers of agriculture from Algeria, the USSR, Australia, and Jamaica were welcomed by the Centre.

The Centre continued extensive involvement in international cooperative programs for research and development in Venezuela, Brazil, the Philippines, and Cuba in the areas of dairy cattle and poultry breeding and dairy cattle production research. An ARC project was initiated to produce Criollo × Holstein cattle to evaluate their performance under Canadian climatic conditions. Criollo × Holstein cattle will also be evaluated in Venezuela.

Members of the research staff were recognized for their tradition of scientific excellence. In 1983, Dr. Hamish Robertson was made a Fellow of the Institute of Biology. Dr. André Fortin received the Young Scientist Award of the Canadian Society of Animal Science.

For the second time in 5 yr, ARC researchers received the prestigious Merit Award of the Government of Canada. In December, merit awards were presented to Drs. Frank Sauer and John Kramer for their joint research on canola (rapeseed) biochemistry, nutrition, and toxicology. This research has clarified the nutritional value of high- and low-erucic-acid rapeseed oil. Drs. Kramer and Sauer were two of the three editors as well as major contributors to a definitive book on rapeseed oil published by Academic Press.

The sudden death of Keith Hollands, a valued member of the poultry breeding and production program, was keenly felt by all staff. His research efforts in the areas of physiological genetics of poultry including cholesterol levels and green muscle disease were major contributions.

Detailed information on the research accomplishments, methodology, and results can be obtained from the publications listed at the end of this report. Reprints of these publications and copies of this report are available on request from the Animal Research Centre, Headquarters Building, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

R. S. Gowe
Director

ANIMAL WASTE UTILIZATION

Changes in composition of farm animal wastes during storage

Changes have been studied in the composition of dairy cattle manure slurry as well as its liquid fraction which was obtained as the supernatant after centrifugation. The slurry was stored, undisturbed, for 285 days in two covered concrete tanks filled in the winter, and for 146 days in two similar tanks filled in the summer. Each tank was 12.3 × 7.2 × 3.0 m deep. Most of the total and ammonia nitrogen (TN and AN, respectively) in the slurry was found in the liquid fraction. With storage, TN concentrations decreased in the slurry but increased in the liquid fraction, whereas AN concentrations increased in both. During storage, the loss of the original TN in the slurry from the winter- and summer-filled tanks averaged 6.4 and 9.1%, respectively. Corresponding increases in the slurry AN content averaged 17.2 and 23.5%. Volatile fatty acid (VFA) concentrations generally increased in the slurry during storage. It was noted that these concentrations were substantially in excess of those normally associated with steadily operating digesters for methane production. Distribution of VFAs in all tanks was relatively steady and similar most of the time. On a molar basis, acetic, propionic, butyric, isobutyric, valeric, and isovaleric acids averaged 67.7, 15.6, 9.6, 2.3, 1.6, and 3.2%, respectively, of the total VFAs. Analyses of data on the solids and mineral content of the slurry are under way.

Effect of alternative manure-cropped systems on soil, crop, and water quality

Long-term effects of different methods of application of manure slurry on crop yield and quality, on selected physical and chemical properties of soil, and on the quality of shallow groundwater are under investigation in a project to be conducted for several years in cooperation with the Land Resource Research Institute (Ottawa). Slurry is applied by plowdown in the fall and by discing, injection, and side-dressing in the spring using commercial-scale machinery. The objective of this recently initiated study is to identify slurry utilization techniques that would minimize degradation of soil and water and enhance crop production over the long term.

Production of feed algae through tertiary treatment of municipal wastewater

The quantity and quality of algal biomass that could be produced for animal feed from secondary effluents at two small wastewater treatment plants was determined on a pilot scale in a contract research project. Algal biomass was produced in batch cultures using an inoculum of the green microalga *Scenedesmus* sp. Production on a dry-weight basis averaged 0.39 mg/L.h from one plant and 1.02 mg/L.h from the other. Biomass production depended on both climatic conditions and effluent composition. The protein content of the biomass at 25–30% was low, probably due to the slow recovery of algae by centrifugation or ultrafiltration which resulted in aging cells that may have lost protein rapidly. Accumulation of heavy metals, selected pesticides, and organochlorinated compounds by the algal biomass was not evident.

TRACE MINERAL AND BEEF CATTLE NUTRITION

Vitamin D_3 metabolism

In sheep given a large intramuscular dose of vitamin D_3, it was observed that the depletion of this liposoluble vitamin proceeded slowly. The rate of tissue uptake varied and the vitamin was stored primarily in adipose tissue. One month after administration, adipose tissue levels amounted to approximately 220 ng/g fresh tissue and 7 mo later appreciable amounts were still present. Kidney, pancreas, and liver also accumulated a significant amount of the dose which was retained for more than 4 mo. The results showed that vitamin D_3 was taken up rapidly by various tissues and retained over a long period.

Ewes that received a single, massive intravenous dose of vitamin D_3 produced a peak sixfold increase in the level of plasma 25-hydroxy vitamin D_3 (25-OHD_3) within 1 day. This elevated level was maintained for 10 days but by day 20 a substantial decline had occurred. Intravenous administration of 25-OHD_3 produced a fivefold increase in plasma 25-OHD_3 concentration as compared with the level in sheep that received vitamin D_3. By days 10 and 20 the level of 25-OHD_3 had fallen to one-half. In ewes injected with vitamin D_3, the vitamin D_3 concentration in the milk increased sharply within 1 day and remained elevated more than 10-fold for 10 days. By the 20th day the concentration in the milk had returned to the preinjection level. These observations suggest that in the suckling ruminant, indirect supplementation with vitamin D_3 may be achieved through maternal injection and subsequent mammary transfer.

Gastrointestinal solubility and absorption of minerals

To collect rumen, duodenal, and ileal digesta, four sheep were each fitted with a rumen cannula and reentrant cannulas in the proximal duodenum and terminal ileum. The sheep were fed corn silage, corn silage with urea added, formic acid-treated alfalfa silage, or wilted alfalfa silage in a Latin square design. The soluble portions of Mn in rumen fluid, ileal digesta, and feces were much lower for alfalfa silages than for corn silages. However, the soluble portions in the duodenal digesta did not differ among treatments. The soluble portions of Zn, Cu, and Fe were not as consistent as those of Mn. The apparent absorption of Zn was negative for alfalfa silages and was associated with the lower soluble portion of Zn in the duodenal digesta and higher portion in the ileal digesta, as compared with corn silages. The apparent absorption of Fe was much higher for corn silages than for alfalfa silages.

Measurements of macrominerals showed that although the soluble portion of Ca in the duodenal digesta was higher for corn silages than for alfalfa silages, sheep fed corn silages showed negative apparent absorption, which was –32.7 and –16.5% for corn silage and corn silage with urea added, respectively, owing to the low concentration of Ca in whole-plant corn. There were no appreciable differences in soluble portions, flow, and apparent absorption of Ca, Mg, and P between the corn silages or the alfalfa silages. The method of ensiling whole-plant corn and alfalfa does not appreciably affect the mineral solubilization or apparent absorption from the gastrointestinal tract. However, the biological availability of Mg is much lower in alfalfa than in corn silage.

Effect of diet and sex on carcass characteristics and sensory properties of beef

Carcass characteristics and sensory properties of rib roasts from 44 bulls and 43 steers of Hereford × Shorthorn breeding were studied. The animals were fed grass silage. A barley supplement was fed at dry matter (DM) rates of 0, 0.45, 0.9, and 1.35 kg/100 kg liveweight. Weight gains ranged from 0.95 to 1.26 kg/day. Each animal was slaughtered at a constant finish value of 8 mm fat measured at the 11th–12th rib.

All treatments resulted in A1 or A2 carcasses. The percentage of wholesale plate and brisket cuts increased linearly ($P < 0.05$) with increasing barley supplementation. Tenderness of rib roasts was similar for all diets. Juiciness and flavor were affected by diet but the differences were so small that the rib roasts from the four treatments were considered to be essentially comparable. Bull carcasses contained a higher ($P < 0.01$) percentage of boneless trimmed chuck and sirloin and boneless trimmed meat than steer carcasses. There was no difference between rib roasts from bulls or steers for juiciness, flavor, or tenderness.

Rumen ciliate protozoa

Six sheep were fed 800 g of a pelleted grain mixture plus 500 g chopped hay on an hourly basis for 6 wk to study the effects of ciliate protozoa on rumen digestion. The sheep had been protozoa-free from birth, and 2 mo before the start of the experiment were fitted with duodenal reentrant and rumen cannulas. Duodenal digesta were collected on three occasions before and seven times after the sheep were inoculated with mixed ciliate protozoa. Within 1 wk of inoculation with protozoa, the flow of amino acids from the stomach had dramatically decreased, from 12.0 to 9.2 g/100 g DM intake. There was a concurrent rise in rumen ammonia and plasma urea levels. Apparent rumen DM digestion (51.4%) and rumen pH (5.85–6.00) were not affected by inoculation.

These findings on amino acid flows using naturally fauna-free sheep confirm previous observations with sheep rendered free from fauna with detergents, and demonstrate that the altered flow is due to the protozoa and not to the chemical used to remove fauna.

DAIRY CATTLE BREEDING AND PRODUCTION

National cooperative dairy cattle breeding project (NCDCBP)

Data from up to five lactations are available for daughters of the selected proven bulls sampled from the source populations and the young sires of the Research Branch Ayrshires and Holsteins used in the pureline foundation matings. Milk yields of progeny groups of the Holstein-based H line were significantly greater than those of Ayrshire-based A line groups in each of the first five lactations. Daughters of U.S. and Canadian proven Holstein bulls produced higher yields than daughters of the Research Branch's young Holstein bulls but did not differ statistically among themselves. Yields of all Ayrshire groups were similar. The average lifetime milk yield to a maximum of five lactations for daughters of Norwegian Red bulls (16 454 kg) was similar to that for daughters of U.S. (16 421 kg) and Canadian Holstein sires (17 249 kg), but this latter yield was achieved by completing nearly an additional half-lactation (2.48, 2.54, and 3.08 lactations, respectively).

Breed-additive, maternal, and nonadditive genetic effects of the various breeds used in the development of the pureline and crossline populations were estimated for heifer reproduction traits. Breed-additive effects were not generally significant, nor were maternal effects. The more important beneficial heterotic effects, expressed as change per 1% increase in heterozygosity, were found with Canadian Holstein × Norwegian Red animals (−1.65 days younger at first conception and −1.81 days younger at first calving). Evidence of increased ages at first conception (0.44 days) and calving (0.47 days) were found with increasing heterozygosity of the Research Branch's Holstein × Finnish Ayrshires.

Beef production from the dairy industry is an important part of the provincial and national beef supply. A cooperative project with the Kemptville College of Agricultural Technology was conducted to compare pureline and crossline dairy steers reared under an eastern Ontario beef production system. At a uniform slaughter weight of 450 kg, C line crossbred steers produced higher-quality beef than either the Holstein H line or the Ayrshire-based A line. Steers from the three genetic groups had similar weights, body dimensions, and feed efficiencies at 1 yr of age. H line steers had better feed efficiency from 1 yr to slaughter than the C or A line. However, carcasses of C line steers had about 1 cm thicker fat cover and a substantially larger proportion were graded A than carcasses of H or A line steers.

Heritability estimates, phenotypic and genetic correlations among udder measurements (such as front and rear teat length and diameter, teat distance, udder height), milking speed, milk yield, and California Mastitis Test (CMT) score were estimated from first-lactation data of the Holstein H line and Ayrshire-based A line. Heritability estimates of most udder measurements, milking speed, and milk yield were moderate, ranging from 24 to 63% and 15 to 61% for the H and A lines, respectively; however, the heritability of teat distance for the H line was only 5%. Genetic correlations of udder measurements with milking speed and milk yield were small and nonsignificant except for front teat diameter and teat distance, which were both positively correlated with milk yield. High-producing cows were milked faster, had lower CMT score, and had udders closer to the ground than low-producing cows.

The potential value of electrical conductivity, somatic cell count, and CMT score as a screening test for subclinical mastitis in composite milk samples was evaluated. All methods identified healthy cows with >90% accuracy but failed to identify a considerable proportion of infected cows. The error rate for misclassification was lowest for CMT score at 9.1%, followed by 13.9% for somatic cell count and 29.4% for electrical conductivity.

Breeding studies using record of performance (ROP) data

New extension factors for predicting 305-day milk and fat yields from lactations in progress were estimated using multiplicative, regression, and nonlinear-model methods. Complete lactation records consisting of eight or nine monthly test-day milk weights and corresponding fat percentages were used. Extension factors were derived for the Ayrshire, Guernsey, Holstein, and Jersey breeds, for two age groups and four seasons of calving. Nonlinear-model factors were at least as accurate as those derived from either the multiplicative or regression method. They also required less computer storage for parameter estimates and could be incorporated more easily into a milk recording program.

Genetic simulation studies

Genetic simulation has great potential in comparing the efficiency of estimating genetic parameters by different statistical methods, since the true genetic values and environmental deviations can be generated with a computer. Two-way mixed-model data sets were generated for comparing Henderson's Method 3 (least squares), maximum likelihood (ML), restricted maximum likelihood (REML), and minimum norm quadratic unbiased estimation (MINQUE) methods of estimating variance components when the data are subjected to various types of selection. Under a no-selection model, REML and MINQUE estimators of sire variances and heritability agreed more closely with true parameters than those obtained by ML or Method 3. The mean squared error for sire variance components was greater for Method 3 than for the other mixed-model procedures (ML, REML, and MINQUE) because the sire random effect was treated as fixed by Method 3 in obtaining the sire sum of squares. The ML estimators of error variance were biased downward, which resulted in an overestimation of heritability. Both selection across fixed effects and selection within fixed effects reduced the parameter estimates in the univariate case, regardless of the estimation procedures studied. Selection within fixed effects was found to affect the parameter estimates more seriously than selection across fixed effects.

Dairy cattle reproduction

Methods for heat detection in large herds of dairy cattle were further evaluated. Testosterone-treated females and heifers treated with estradiol, a female hormone, were both used. The treated females detected only 51% of all heats that occurred, compared with 94% detection by herdsmen who observed standing, mounting, mucous discharge, or any combination. Only 6% of the heats detected by the treated females were not detected by the herdsmen, and these heats occurred during the night period of 1800–0600 h, when the herdsmen were off duty. Estradiol-treated heifers detected a slightly greater percentage of heats than testosterone-treated females, 53 versus 49%, respectively, but there was considerable variation among treated females in both groups. Using a single criterion, the herdsmen detected slightly more cows in heat by observing mounting (76%) and mucous discharge (75%) compared with standing (70%). It is possible that cows in heat are more aggressive and because of slippery barn floors tend to mount other cows in preference to standing and being mounted themselves.

Factors associated with the incidence of cystic ovaries in three lines of dairy cows, housed indoors year-round, were evaluated for parturitions from 1979 to 1981. The incidence of cystic ovaries was 14%, which is approximately the national average. Six percent of primiparous cows became cystic, compared with 18% of multiparous cows. Genetic line and month of calving did not influence the incidence of cystic ovaries. Some reports had suggested a greater frequency of cystic ovaries associated with higher levels of milk production, but this relationship was observed only in 1981 in this study.

A rapid assay system for measuring progesterone levels in milk was implemented to monitor physiological status and to permit early pregnancy testing. The assay is based on immunoenzyme procedures and eliminates the use of hazardous radioisotopes and organic solvents.

Pilot genetic studies with mice

Lifetime performance of the breeding female, measured by offspring born and reared to a productive age, is primarily a trait of the female but includes the contribution of the male mate through libido and survival and growth of offspring. The contribution of males of different genetic backgrounds to the lifetime performance of females under four breeding systems was evaluated using mice.

Six straightbred lines were used to set up five crisscross (CC) lines, five repeat hybrid male cross (RHMC) lines, six straightbred (STR) lines, and a synthetic (SYN) line. Females in each line were pair-mated with males of the corresponding line and breeding system (Group I) or males from SYN (Group II). Under the CC system, involving two breeds (lines), female crossbreds are mated with males from breeds that alternate between generations. Under the RHMC system, female crossbreds are mated in successive generations with F_1 hybrid males from two breeds (lines). After mating, pairs were maintained for a lifetime of 155 days. Data from six generations were analyzed to examine lifetime performance in Group I minus Group II for each line/generation. Line-of-male effects, under CC, RHMC, and STR systems, averaged over generations and expressed as percentages of the difference from the use of SYN males, were –11, +5, and –2 for number of parturitions during 155 days; –12, +3, and –7 for total number of young born alive; –12, +2, and –8 for total weight (g) of young born alive; –12, +3, and –8 for total number of young at weaning; –11, +2, and –8 for total weight (g) of young at weaning; and –8, +3 and –1 for actual days of reproductive life, respectively. Lifetime performances of females differed, depending on males used for mating. F_1 hybrid males were superior to SYN males, which in turn exceeded STR males in their contribution to female lifetime performance.

DAIRY CATTLE NUTRITION

Protein degradation in the rumen

Formaldehyde treatment of soybean meal. Soybean meal is rapidly degraded in the rumen to free ammonia, amino acids, and carbon skeletons of the corresponding deaminated amino acids. Some of the ammonia thus liberated is resynthesized into protein by rumen microbes, but the digestibility of the microbial protein in the lower gut is less than that of the original soy protein. Treatment with formaldehyde is a means of protecting soy and other proteins from rumen degradation. The efficacy of formaldehyde-protected soybean meal protein was tested when fed in conjunction with urea-treated corn silage as a source of nonprotein nitrogen. Control corn silage and untreated or formaldehyde-treated soybean meal were fed to lactating dairy cows. Three diets were developed, with the control diet (A) containing 11.3% crude protein (CP) and diets B and C containing a total of 14.7% CP formulated with untreated and formaldehyde-treated soybean meal, respectively. Concentrates were mixed 50:50 on a dry matter basis with corn silage and fed ad libitum. All animals received diet B during the first 4 wk postpartum and then were switched to their allocated ration until 16 wk. At this stage, five animals from each group were placed on a 7-day period of feces and urine collection. Milking was at 0600 and 1530 h daily. Milk samples were taken weekly from two consecutive evening and morning milkings for fat, protein, and lactose determination. Rumen fluid was taken by stomach tube during the 3rd, 4th, 9th, and 10th wk postpartum and analyzed for volatile fatty acid and ammonia contents and numbers of rumen protozoa and bacteria.

Milk production and solids-corrected milk production, which were both corrected with wk 1–4 production as a covariate, were not significantly affected by protection of the soybean meal. However, there was a significant reduction in dry matter intake of cows fed the diet containing formaldehyde-treated soybean meal. The percentage of milk protein was significantly lower when protected protein was fed.

The digestibility of DM was significantly depressed when diet A was fed; however, no adverse effects were noted for diet C. The digestibility of N was significantly decreased, to 51.6%, with the low-protein diet compared with results from the diets containing either treated or untreated soybean meal. N digestibility was significantly decreased, to 58.6%, with the treated soybean meal diet compared with 64.0% for the untreated diet. Comparisons are currently under way to determine whether the combination of protected soybean meal and urea-treated silage will improve lactation performance.

Heat treatment of soybean meal to reduce degradability. Heating soybean meal at 149°C for 2.5 h or at 100°C for 24 h gave products whose in vitro degradation by rumen protease was reduced by 50%. Application of dry heat at 95°C for 35–45 min did not protect the protein from degradation. Heating in steam at 105°C for 1 h reduced protein dispersibility from 64 to 14 and the in vitro protein degradability by rumen protease by 30%. Thus the results were variable depending upon the conditions of heat treatment. However, heat treatment promises to be a practical nonchemical method of producing protected feed proteins for ruminants.

Forage evaluation

Studies have compared the effects of harvesting alfalfa at two stages on yield, recovery of nutrients when the crop is preserved as silages in concrete stave silos (3.7 × 12 m), chemical composition, and digestibility in dairy cattle.

For early-cut forage, alfalfa was harvested at an early stage of maturity on 14 June 1982 and preserved as direct-cut formic acid-treated silage (EFS) or wilted silage (EWS). These forages were compared with wilted silage of late-cut alfalfa (LWS) harvested 15 days later at full bloom. DM yields of EFS, EWS, and LWS forages at storage were 2.91, 2.82, and 3.12 t/ha, respectively. For silages fed during the spring of the subsequent year, DM recoveries from storage were 80, 86, and 86%, respectively. Corresponding values were 84, 92, and 88% for energy recovery and 78, 92, and 92% for crude protein (CP) recovery. The lower recoveries from EFS resulted from excessive leaching in the effluent from formic acid-treated alfalfa, which was stored at 78% moisture content, whereas EWS and LWS were stored after wilting to 69 and 63% moisture contents, respectively. Fifteen days delay in harvesting alfalfa resulted in increases of 4.2% in cell wall and 1.2% in lignin contents. As a result, digestibilities of nutrients in LWS were significantly lower than corresponding values for EWS. For EFS, EWS, and LWS, the values for DM digestibilities were 59, 59, and 55%, respectively. Corresponding digestibility values of nutrients were 57, 60, and 55% for energy; 65, 66, and 62% for CP; and 56, 57, and 50% for cellulose. The total digestible nutrients (TDN) expressed as percentages of DM were 60, 66, and 59, respectively, and corresponding values for CP were 17.7, 18.7, and 18.3. The heat-damaged CP was 8.5, 7.4, and 7.9%, respectively, of total CP for each forage. Thus a delay of 15 days in harvesting adversely affected the quality of wilted alfalfa silage when it was fed alone. When it was fed in combination with corn silage, on a 50:50 DM basis, the same trend persisted but differences were small and not significant. TDN values for three combinations averaged 66% of DM, as compared with 76% for the control diet of corn silage plus soybean meal fed on an 8:1 DM basis.

Separation of the proteases of rumen microorganisms that degrade casein and feed protein

In the past it had been assumed that the capacity of rumen microorganisms to degrade casein could be equated to their capacity to degrade feed proteins. This assumption was evaluated in an experiment in which the total portion of mixed rumen microoganisms showing protease activity against casein was recovered in powder form by treatment with organic solvents. From an aqueous extract of the powder, two protein fractions were separated, one consisting of all proteins with molecular weights less than 300 000 and the other of proteins with molecular weights more than 300 000. Both fractions were found to have protease activity against casein but only the fraction with molecular weight over 300 000 was capable of degrading feed proteins.

Application of biotechnology to rumen bacteria

Protein produced by rumen bacteria normally meets the major part of the cow's requirements. This protein cannot be used to maximum efficiency because it contains inadequate levels of specific amino acids, the most limiting being lysine, methionine, and threonine which are essential for protein synthesis in the ruminant. Genetic engineering techniques may increase the level of these amino acids in the microbial protein so that the efficiency of utilization of microbial protein by the animal will be greater and the requirement for expensive dietary protein supplements will be correspondingly reduced. A gene coding for a polypeptide 88 amino acids long for lysine, methionine, and threonine and containing appropriate control sequences to regulate the rate of polypeptide production has been constructed using a combination of chemical and enzymatic techniques; it has been inserted into a plasmid vector in *Escherichia coli*. Research is developing plasmid vectors suitable for the maintenance of such new genetic material in rumen bacteria. Methods for the introduction of plasmid vector DNA into the rumen bacterium *Butyrivibrio fibrisolvens* have been tested and one plasmid, pRK248, has been found that is capable of expressing foreign genetic material in this rumen bacterium.

Calf nutrition

Tolerance of calves for fat peroxides in milk replacer. Soybean oil oxidized by aeration at 60°C was incorporated into milk replacers to provide peroxide levels of 0.39 (control), 2.0, and 20.6 meq/kg of feed DM. Calves fed the three milk replacers from 3 to 31 days of age gained 0.463, 0.502, and 0.470 kg/day. There was no effect of dietary peroxidized fat level on average daily gains, feed intake, or feed efficiency and no evidence of accumulation of peroxides in liver, kidney, heart, or adipose tissues, as shown by fluorescence and thiobarbituric acid-reactive materials. The study showed that preruminant young calves can tolerate relatively high dietary peroxide levels without any deleterious effects on growth and feed efficiency.

Effect of fatty acids on calf weight gains and feed efficiency. Calves were fed milk replacers based on skim-milk powder and containing as a lipid source tallow, corn oil, coconut oil, or the free fatty acids derived from these fats. Tallow contained mostly saturated long-chain fatty acids, corn oil mostly unsaturated long-chain fatty acids, and coconut oil a large proportion of medium-chain fatty acids, which in the free form are much more easily absorbed than the long-chain acids. The groups fed tallow and coconut oil showed excellent weight gains and feed efficiencies. Calves fed corn oil had poor gains and feed efficiencies, low levels of digestibility of nutrients, and severe scours. When the fats were replaced by their free fatty acids, tallow fatty acids gave poorer gains than tallow fat because of poor absorption of palmitic and stearic acids. Free fatty acids of coconut oil gave poor feed intake and growth because they were unpalatable. Free fatty acids of corn oil worsened the already poor performance of corn oil-fed calves. The two studies showed that although cheaper trade fats may be used in calf milk replacers if the peroxide level is relatively high, free fatty acid content must not be high to avoid poor calf performance.

SWINE PRODUCTION

Effects of vomitoxin on production

An experiment with 24 pregnant gilts assessed the effect of vomitoxin-contaminated wheat on feed intake, growth rate, and embryonic development. A second experiment with 30 gilts extended these studies through pregnancy and a 3-wk lactation. Other research has examined the interacting effect on appetite and growth rate of diets containing both vomitoxin and zearalenone, an estrogenic mycotoxin. The efficacy of antitoxin substances to counteract the effects of vomitoxin on pig production has been examined and an experiment is also under way with 64 pigs to determine the effect of vomitoxin-contaminated feed when fed to animals from weaner age through to market weight. These results are reported in the section entitled "Animal feed safety and nutrition."

Behavior and welfare of pigs

Death of piglets through inadequate nutrition is an important drain on the pig industry, and poor nursing and suckling behavior has been identified as a major cause. Research is assessing how litter size, farrowing crate design, and other aspects of sow management influence suckling behavior, colostrum intake, and subsequent piglet growth and survival. Experiments on the availability of colostrum to piglets showed that, although milk yield in the established lactation does not vary greatly from the anterior to posterior end of the udder, colostrum yield during farrowing is substantially higher from the anterior positions.

To reduce costs, many pig producers resort to liquid-manure handling and have eliminated the use of bedding. This is one of the major controversies concerning the welfare of intensively housed pigs. Research is assessing the specific benefits of bedding, such as improving floor comfort, providing an outlet for exploratory activities, and serving as a source of dietary fiber. In two experiments, 6-wk-old pigs were given access to a pen with a solid concrete floor and an identical pen with straw bedding. At a cool ambient temperature of 20°C, the pigs generally selected a resting area in the bedded pen, whereas at 25°C, the temperature recommended for their age, no pigs selected the bedded lying area.

A two-level pen has been developed for grower pigs. This design is expected to give an economical means of increasing floor space while addressing certain animal welfare concerns over intensive housing. The pen provides food on an upper, solid-floor level and water on the lower, slotted-floor level. Access between the levels is by a ramp. Preliminary testing indicates satisfactory health and performance of pigs in the two-level pen compared with those in a control pen.

Reproductive physiology

Improved reproductive performance remains the major problem facing the swine industry. Research to reduce embryonic and postnatal mortality will increase the number of healthy pigs weaned per sow per year. Studies are providing a better understanding of the basic endocrinology involved in fertilization, placental attachment, and the role of the corpus luteum. For example, the finding that estrone sulfate is present at day 16 in the pregnant sow might give rise to a technique for an early pregnancy test.

Carcass evaluation

In Canada, the grade given a hog carcass is a function of backfat thickness and carcass weight. Research was conducted to improve both the methodology and technology of this grading procedure. A single backfat measurement has been found to be as effective and efficient as the traditional two measurements. Electronic measuring (probing) equipment also is being tested to improve carcass evaluation and the operational efficiency in abattoirs.

The quality of boar carcasses compared with those of barrows was investigated. The lean yield of the boar carcass was greater than that of the barrow and the lean meat contained less fat (ether extract) but the same amount of protein.

POULTRY BREEDING

Selection and flock management studies in egg-laying chickens

Two Leghorn strains, selected for more than 30 generations, demonstrated that genetic parameters are relatively stable. There was no evidence that genetic variances or heritabilities had decreased over the selection period. This was despite the inbreeding coefficient which rose to more than 20% for both strains. The genetic correlations also were relatively constant. However, additive genetic variation and sire estimates of heritabilities of the selected strains were lower than those of the unselected control. It was concluded that changes in genetic parameters apparently occur rapidly in the first few generations of selection and thereafter, parameters are stable or changes are slow and not easily predictable. Hence, it is no surprise that none of the traits under selection appears to have reached or to be approaching a selection limit.

At the end of the first laying cycle of the six selected and three control strains, carcass composition, particularly abdominal fat content (leaf fat), was examined. For all strains, leaf fat, expressed as a percentage of total carcass weight, ranged from 2.5 to 4.8% with a mean of 3.4%. Selected strains (1, 3, 8, and 9) had a mean of 2.6% leaf fat and were leaner than comparable control strains (5 and 7) which averaged 4.3% leaf fat.

In a separate study, the spur lengths of hens over 500 days of age were measured. For all strains, spurs on the left and right legs were of comparable length and ranged from 0.25 to 2.27 cm with a mean of 0.91 cm. Selected strains (1, 3, 8, and 9) had longer spurs than comparable control strains (5 and 7) and averaged 1.03 versus 0.83 cm, respectively. Strains 1, 2, and 9, which were selected with hen-day rate of production as the primary trait, had longer spurs than strains 3, 4, and 8 which were selected primarily for egg numbers (1.22 versus 0.67 cm, respectively). Spur size is believed to be influenced by hormonal levels and the differences observed may be a reflection of changes in these levels under the selection practiced.

In continuing studies of brooding and rearing management, the tier within a three-deck group rearing cage had little effect on viability or subsequent performance. The brooding and rearing of strains either intermingled or separately had only small effects on viability, in favor of strains brooded and reared separately. A 2-yr study of use of red versus white light during brooding and rearing showed that birds reared under red light had slightly higher viability, housing body weights, rate of lay, and egg quality than those brooded and reared under white light.

Two methods of inducing a molt in laying hens using reduced photoperiod and restricted feeding were compared. These are the California normal molt method and the Washington State University molt method. Hens on the California molt went out of production more quickly, resumed production sooner, and had higher peak egg production after molting than those on the Washington molt.

Genetics of poultry meat production

Literature indicates that sex-linked genetic and maternal effects are frequently important in accounting for differences among broilers. If these effects exist among broiler parent stocks, they would account for differences between progenies from reciprocal crosses and could be used by breeders to improve broiler performance. Production of two-way and four-way crosses, during synthesis of sire and dam populations of meat-type chickens from commercial broiler parent stocks, permitted comparisons of reciprocal and other crosses to detect differences among stocks in body weights at 6, 20, and 52 wk of age and body conformation traits at 6 wk of age.

Differences among reciprocal crosses were rarely important. Hence, genetic stock differences attributed to sex-linked genetic or maternal effects, or both, were of little importance. Selection among various stocks for these effects does not appear promising. If breeders wish to use these effects to improve broilers they must test and select within strains.

Rates of protein and fat accretion of slow- and rapid-growing strains of chickens reared as broilers were measured and compared. Samples of each strain were slaughtered at biweekly intervals from 1 to 17 wk of age to measure body weight and amounts of protein and lipid in the carcass. Preliminary analyses revealed that (*a*) the rapid-growing strain grew twice as fast as the slow-growing strain; (*b*) the relationship between weight gain and protein accretion was linear for the period studied; (*c*) strains differed very little in protein accretion after adjustment for carcass weight; (*d*) a complex relationship existed between weight gain and fat accretion, although fat proportion did increase as the broiler grew; and (*e*) much of the difference in fatness between strains was removed when results were adjusted for differences in carcass weight.

Studies of techniques to determine carcass fatness of broilers continued. Correlations between levels of lipoproteins of very low density in plasma and percentage of carcass fat were positive and moderate in size. These results are similar to those obtained by other researchers using other strains. Hence, this measure could assist in predicting fatness in live birds.

Disease resistance genetics

Green muscle disease is a degenerative disease which causes disfiguration and atrophy of the deep wing-elevating muscle of the breast in adult meat-type chickens. Results of three generations of selection suggested that incidence of the disease could be lowered. It was previously established that plasma creatine kinase levels after exercise were positively correlated with disease incidence. This knowledge was used to select the third generation, where the best selection response of the three generations was observed. The estimated heritability of 0.4–0.5 indicated that progress in selection against the disease could be made reasonably quickly.

A long-term selection study, conducted in cooperation with the Animal Diseases Research Institute (Nepean, Ont.), was recently concluded. It combined selection for resistance to Marek's disease, a lymphoproliferative viral disease of chickens, with selection for high egg production and related economic traits. The study was conducted in three replicates and yielded three "resistance-selected" strains of Leghorns. They were formed by selection and inbreeding from corresponding "long-term selected" strains that were selected similarly to the resistance-selected strains but without specific selection for resistance to Marek's disease and inbreeding. In addition, two of the original populations of the genetic base from which the selected strains were derived were also maintained as unselected control strains.

The resistance-selected strains were shown to be highly resistant to Marek's disease, but under vaccination against Marek's disease two performed somewhat less well than the corresponding long-term selected strains. Without vaccination, performance of all resistance-selected strains exceeded that of the long-term selected ones. With or without vaccination, performance of the selected populations was substantially improved over that of the control strains.

The major genetic complex for histocompatibility, which is referred to in chickens as the *B* system, is involved in resistance to Marek's disease and may also play a role in the regulation of reproduction. The changes induced in the *B* system by selection were studied in cooperation with the Institute of Experimental Immunology (Copenhagen, Denmark), in one of three replicates. Unselected control strain 7 had at least seven haplotypes, ranging in frequency from 0.06 to 0.21. Long-term selected strains 8 and 9 had at least six haplotypes, ranging in frequency from 0.03 to 0.47, with the B^{21} haplotype having the highest frequency. Resistance-selected strain 8R showed only four haplotypes, with haplotypes B^{21} and B^{2} at frequencies of 0.59 and 0.36, respectively.

Thus, artificial selection for high egg production and resistance to the Marek's disease herpesvirus dramatically affected the histocompatibility complex. The results confirmed previous findings that B^{21} is associated with resistance to Marek's disease and suggested that B^{2} was the next most advantageous haplotype. This result has a direct application in poultry breeding where commercial breeders are determining *B* haplotypes by blood tests and are able to influence haplotype frequencies by selection.

Eggshell quality

Vitamin D and estrogen are two important factors in the control of Ca mobilization for eggshell formation. A study was initiated to determine how a deficiency of vitamin D would affect estrogen metabolism, in order to elucidate their complex interaction and mechanism of action. In laying hens that are deficient in dietary vitamin D_3, poor eggshell quality and low plasma Ca levels were accompanied by a specific enzymic defect in estradiol-17β metabolism. Under this condition, there was an abnormally high accumulation in the blood of estradiol-17β-3-sulfate which normally is further metabolized to estradiol-17-α-3-sulfate.

Geese

Previous research had shown that 2-yr-old geese of Chinese and synthetic strains (the latter developed from Chinese, Pilgrim, and Hungarian breeds) produced more eggs under a regimen of 10 h light and 14 h darkness (10L:14D) than under 13L:11D. The former regimen was applied directly and the latter gradually after a 7L:17D regimen.

In rearing studies the progeny of these geese were housed as pullets in December under 7L:17D. In mid-January half the geese were given 10L:14D and the others given increases in light of 15 min/day from 7 to 10 h and then 15 min every 2 wk until a level of 11L:13D was attained. During a 20-wk period, production of survivors was similar for the two treatments, being 43 and 44 eggs for the Chinese and 33 and 32 eggs for the synthetic strain under the 10L:14D and 11L:13D treatments, respectively.

POULTRY NUTRITION

Performance of broilers fed diets containing naked oats

Oats can be grown in many parts of Canada, but a high fiber content limits their use for poultry. A naked variety of oats, OA503-1, recently developed by the Ottawa Research Station contains crude protein at 177 g/kg and has an excellent amino acid profile. Lysine appears to be the limiting amino acid, but a level of 6880 mg/kg DM (with N at 243 mg/g) is high compared with that in other cereals commonly used for poultry feeds. When naked oats were included at levels of 300 and 600 kg/t to replace corn and up to 25% of the soybean meal in broiler grower diets, their use resulted in gains equal to those obtained with a standard corn–wheat–soybean diet. Feed efficiency was equal to that of the corn–wheat–soybean diet when naked oats were included at 300 kg/t but was lower for the diet at 600 kg/t. Carcass quality was not affected by the inclusion of naked oats. These results indicate that naked oats could replace a substantial portion of corn and soybean meal now used in poultry diets.

Intermittent light and broiler production

Results of a previous experiment with two genotypes of broiler chickens showed that intermittent lighting reduced the quantity of body fat. In a further study with eight commercial broiler genotypes, efficiency of utilization of feed for weight gain was consistently higher for the birds receiving intermittent lighting than for those under a continuous lighting program. Lower abdominal fat content in female broilers was obtained with intermittent lighting, but this effect occurred in males for only five of the eight genotypes tested. Overall, weight gain was not affected by lighting program, but for certain genotypes weight gain was more variable with intermittent than continuous lighting.

Bioassays for bioavailable energy

True metabolizable energy (TME) differs from other estimates of bioavailable energy inasmuch as a correction is made for metabolic plus endogenous energy losses. To enable such losses to be understood better, the fasting energy and nitrogen excretions of adult cockerels were measured in a longitudinal study at 28-day intervals for 13 mo. Variables found to affect the losses included genotype, metabolic size, and environmental temperature. Of particular importance was the finding that the energy value attributed to N, and used to correct bioavailable energy values to zero N balance, may vary among birds and over time, and may be related to metabolic size.

An experiment examined whether precision feeding, an important element of the TME system, caused symptoms of stress. There was a very low incidence of abnormal behavior among precision-fed birds. Reports of abnormal behavior can probably be explained by the relatively long periods required for feed administration at other laboratories.

Utilization of dietary energy

Changes in carcass composition associated with TME intake were measured in broiler chicks. The gross energy values of carcass fat and protein were estimated to be 39.5 and 24.5 MJ/kg, respectively. Retained energy increased in a linear manner with TME intake (both expressed as $\mathrm{MJ}/W_{\mathrm{kg}}^{0.75}$ per day). The slope of the line was greater for a lipogenic than for a proteogenic diet. Extrapolation to zero TME intake gave an estimated body energy loss of 0.420 $\mathrm{MJ}/W_{\mathrm{kg}}^{0.75}$ per day, which is an estimate of the net energy requirement for maintenance. Energy retained as fat or protein had different slopes when plotted against energy intake. Of particular interest was a curvature in the lines at low levels of retention, which appeared after 14 but not 7 days. When energy retention was zero, there was energy gain as protein and energy loss as fat. Consequently, the energy intake required for zero retention is of questionable value as an estimator of the maintenance requirement.

Relationship between laboratory measures of shell quality and breakage in commercial egg washing and candling equipment

Few data are available on the relationship between measures of shell strength obtained with various laboratory procedures and shell breakage. When eggs with intact shells were passed through the washing and candling unit of a small commercial egg grading system (2700 eggs/h), those found to have broken or cracked shells after the first, second, and third wash cycles were 8.0, 13.1, and 13.3%, respectively. The broken or cracked eggs were removed after each wash cycle. The eggs were then evaluated for shell strength using conventional laboratory methods. Comparison of the data for the intact and broken or cracked eggs indicated that some breakage was due to chance rather than shell strength, because some eggs with "strong" shells were broken or cracked while others with "weak" shells remained intact. Ranking of the hens according to increasing shell strength of the eggs from each bird indicated that about 32–48% of the breakage occurred with eggs from hens ranked in the lowest quartile (<25%) and about 12–25% for eggs from birds in the highest quartile (>75%). There was a rather close agreement in the percentage of breakage within each quartile among shell weight, shell thickness, specific gravity, quasistatic compression fracture strength, and nondestructive deformation. These results indicate that specific gravity, compression fracture strength, and deformation were comparable in their ability to predict shell breakage.

Daily variation in egg shell strength

Since results from several experiments had indicated the possibility of day-to-day variation in egg and shell weight, shell strength, and feed intake, two experiments using White Leghorn pullets and force-molted hens were conducted to examine more thoroughly the daily variation over successive 14- and 56-day periods. Plots of daily means and ranges showed systematic variation from day to day, with marked changes occurring within a few days for feed intake, egg and shell weight, percentage of shell, shell thickness, egg specific gravity, nondestructive deformation, and quasistatic compression fracture strength. Little evidence was found of a relationship between day and feed intake and shell quality, or of interactions between strain, age, or room in which the birds were housed. These results show that research on egg shell strength should be planned so that systematic daily variation is not confounded with treatment comparisons.

SHEEP PRODUCTION

Development of specialized synthetic sire and dam strains

Repopulation of a minimum-disease flock, comprising one synthetic sire strain, two synthetic dam strains, and three control strains established from lambs obtained by hysterectomy in 1980, has continued. Matings in January, May, and September 1983 have maintained the genetic base. Two flocks, with equal contributions of genetic material from the synthetic and control strains, have been reestablished. These flocks will be mated alternately at 4-mo intervals beginning with the January 1984 mating. Data from successive matings will be used to estimate genetic trends for both direct and correlated response to selection for increased reproductive and growth traits in the dam strains and for increase in lean muscle mass and meat yield in the sire strain.

Studies have shown that a greater genetic response to selection for lamb weight can be achieved with lambs reared artificially than with lambs reared with their dams. In the absence of artificial rearing, prospective breeding stock reared with their dams should be tested for postweaning growth performance to permit full assessment of transmitted sire differences.

Breed, birth date, age of ram, and body weight have been shown to have a significant influence on testicular and body growth of ram lambs. Age of dam and litter size effects were absent. It is concluded that effective appraisal of the genetic potential of these traits can be achieved only by eliminating variation due to environmental factors.

The main objective in establishing the minimum-disease flock was to eradicate Maedi Visna disease, a slow viral disease resulting primarily in a progressive pneumonia and ill-thrift. Serological testing of a random sample of 300 hysterectomy-derived ewes at 32 mo of age revealed no positive reactors to the Maedi Visna test. Monitoring of animals in the flock will continue to determine the effectiveness of the hysterectomy procedure to eliminate diseases transmitted from dam to offspring.

Intensive rearing of lambs

Lambs have been shown to perform equally well when raised artificially from birth to 21 days of age on a standard milk replacer (MR) formulation fed at 4°C or on a MR with formalin added at a level of 1 mg/kg of reconstituted MR and fed at room temperature. Abomasal bloat, usually associated with feeding MR ad libitum at room temperature, was essentially eliminated by addition of formalin. Moreover, lambs appear to be more easily trained to drink MR at room temperature.

Maximum postweaning growth performance has been achieved by lambs given diets containing 20% protein, on an as-fed basis, from weaning at 21 days until 56 days of age; 17% protein from 57 to 98 days; and 17% protein from 99 to 140 days. However, a 17–17–14% protein sequence results in only a slight reduction in weight gain and may be more economical.

Reproductive physiology

Synchronization of the estrous cycle. Studies have evaluated a progesterone-containing intravaginal device, consisting of a plastic core covered with an elastomer containing approximately 550 mg progesterone, to synchronize estrus and ovulation in ewes. Insertion of the device into ovariectomized ewes for 12 or 14 days increased the plasma progesterone from a basal level of 0.5 ± 0.1 ng/mL to a peak of 4.8 ± 0.8 ng/mL within 4 h. The levels declined to 3.0 ± 0.5 ng/mL within 48 h and decreased gradually thereafter to 1.7 ± 0.3 ng/mL at the time of removal. Following removal, the plasma progesterone fell to basal levels within 4 h. Estrus and ovulation were effectively synchronized in adult ewes treated with progesterone-containing devices for 12 or 14 days, irrespective of whether the treatments were initiated at the beginning, the middle, or the end of the estrous cycle. Furthermore, after treatment of adult cycling ewes with progesterone-containing devices or with intravaginal sponges impregnated with fluorogestone acetate (FGA) for 14 days and 500 IU of pregnant mare's serum gonadotrophin at withdrawal, approximately 92% of ewes in both treatment groups were marked by rams within 72 h, suggesting a high level of estrus synchronization. These results show that the progesterone-containing device provides a sustained release of progesterone which is absorbed by the vagina to produce plasma progesterone levels within the normal physiological range. It is effective in synchronizing estrus in adult cycling ewes and offers a promising alternative to the FGA-sponge treatment.

Artificial insemination. Studies to determine the optimum conditions for preservation of ram spermatozoa during freezing and thawing have continued. Ram spermatozoa will tolerate a range of cooling velocities of 1–100°C/min for a given glycerol concentration, when frozen in a lactose–egg yolk–glycerolated skim-milk diluent in which the final glycerol concentration varies from 0 to 16%. The best survival rates, as determined by percentage of motility and rate of forward progression after thawing in a water bath at 39°C for 30 s, were obtained at glycerol concentrations of 4–6% and a freezing velocity of 10–100°C/min. The toxic effect of increasing the glycerol concentration over 8% contributed significantly to the decrease in survival of ram spermatozoa. Also, it has been shown that optimum freeze–thaw survival of ram spermatozoa could be achieved after equilibration of extended ram semen at 5°C for 2–6 h before freezing in a lactose–egg yolk–glycerolated skim-milk diluent.

A standard procedure has been established for in vitro assessment of the potential fertilizing capability of fresh ram spermatozoa, based on entry into and penetration of bovine cervical mucus. A 40-μL capillary tube, filled with bovine mucus and sealed at one end, is suspended in a culture tube so that the open end of the capillary tube is immersed in 1 mL diluted ram semen containing 100×10^6 spermatozoa per millilitre. The culture tube is capped and incubated at 37°C for 60 min. Under these conditions, the rate of spermatozoa migration into the mucus is linear for at least 20 min. The distance traveled by the leading spermatozoa in 20 min is defined as the sperm penetration distance (SPD). A given semen sample shows different values of SPD in mucus from different cows. To facilitate reproducible results and comparison of semen samples, mucus from several cows is pooled and frozen to provide a homogenous supply for an extended period. The long-term effects of various artificial photoperiods on testicular function and semen production of rams are being studied in an attempt to stimulate year-round production of high-quality ram semen. Weekly measurements are being made of semen quality, testis size, and blood hormone levels to monitor changes in testicular activity and of citric acid and fructose levels in seminal plasma as indicators of prostate and seminal vesicle function, respectively.

ANIMAL FEED SAFETY AND NUTRITION

Pesticide metabolism

Fenvalerate. Studies on the fate of fenvalerate in laying hens were completed. Consumption of labeled fenvalerate for 7 days at levels of 63.6 and 112.1 ppm did not produce significant changes in egg production, body weight, or feed intake. The absorption and elimination of the ^{14}C component were very efficient, with approximately 72% of the radiocarbon eliminated in the excreta in 24 h and almost 100% by 144 h after the final dose. Radiocarbon was not detected in eggs, gizzard, heart, lungs, leg, or breast muscle. Liver, kidneys, and abdominal fat contained radiocarbon at levels $<0.5\%$ of the total dose and solely during the treatment period. The only compound identified in liver and abdominal fat was unchanged insecticide. The compounds identified in excreta were: fenvalerate (6.8–10.5%), free 2-(4-chlorophenyl)-3-methylbutyric acid and its conjugates (46.5–53.5%), 3-phenoxybenzoic acid (2.9–5.5%), and 4′-hydroxy-3-phenoxybenzoic acid (22.8–36.1%).

Deltamethrin and cypermethrin. The metabolic fate of deltamethrin was studied with the aid of ^{14}C-*gem*-dimethyl- and ^{14}C-benzyl-labeled compounds in laying hens fed the insecticide at 5 mg/kg body weight. The insecticide was efficiently absorbed, metabolized, and eliminated in excreta. Approximately 80% of the administered radiocarbon was eliminated in excreta within 24 h. Small amounts of ^{14}C were also eliminated 48 and 120 h after the last treatment.

Radiocarbon content was low in eggs laid within 24 h after the first dose but increased on successive days. Yolks contained comparatively more radiocarbon than egg whites. During the treatment, intestine contained the highest level of radiocarbon followed by kidney and liver. Other tissues, such as breast and leg muscles, spleen, and fat, contained small but detectable amounts of radiocarbon. The excreted metabolites included: deltamethrin, free 3-(2,2-dibromovinyl)-2,2′-dimethylcyclopropanecarboxylic acid and its conjugates, 2-carboxy-3-(2,2-dibromovinyl)-2-methylcyclopropanecarboxylic acid, 3-(2,2-dibromovinyl)-1-hydroxymethyl-1-methylcarboxylic acid, 2-carboxy-3-(2,2-dibromovinyl)-2-hydroxymethylcyclopropanecarboxylic acid lactone, 3-phenoxybenzoic acid, 3-phenoxybenzylalcohol, and 4′-hydroxy-3-phenoxybenzoic acid. Further analyses of residues in excreta, eggs, and other tissues are under way. Studies on the metabolic fate of deltamethrin in lactating cows and that of cypermethrin in laying hens are planned.

Mycotoxins

Contamination by mycotoxins, especially vomitoxin (deoxynivalenol) and other *Fusarium* toxins, continues to be a major issue in terms of feed and food safety. ARC scientists in collaboration with researchers from other establishments within Agriculture Canada and other federal departments are studying the effects of *Fusarium* mold infection on mycotoxin production in the field; the relationships of dietary vomitoxin levels and productive performance of swine, poultry, and dairy cows; and the levels of vomitoxin residues in poultry and dairy products. Researchers also are assessing the effects of milling on vomitoxin levels.

Nutritional and toxicological feeding trials demonstrated that decreased feed consumption and reduced weight gains in pigs are the main effects of ingestion of low vomitoxin levels of 2 mg/kg feed or 2 ppm.

In surveys of Canadian grains carried out during the past 3 yr, the vomitoxin levels in wheats from Eastern Canada were 8.5 mg/kg at maximum and were probably not high enough to account for reports of complete feed refusal, vomiting, and reproductive problems. This conclusion is supported by the fact that even at highest inclusion levels, grains only form 70–80% of the formulated diets.

Results of the feeding trails indicate that swine can ingest dietary vomitoxin levels of up to 2 mg/kg of feed without serious adverse effects. The addition of a binding agent (Antitox Vana) or ammonium carbonate to diets contaminated with vomitoxin at 5 mg/kg did not appear to alleviate any of the effects of vomitoxin on barrows and gilts. Poultry can tolerate vomitoxin at levels of at least 5 mg/kg feed. In fact, up to these levels some beneficial effects on poultry have been observed. Slight decreases in feed consumption occurred in dairy cattle consuming vomitoxin at 6 mg/kg in a wheat–oats concentrate diet fed at a rate of 1% of body weight per day, plus hay ad libitum.

Studies were conducted to determine whether vomitoxin residues appeared in animal products. Vomitoxin, present in the rations of Leghorn chicks, laying hens, and broiler chickens at dietary levels of 4–5 μg/g for periods of 28–190 days, was not detected in eggs or in drumstick, breast, liver, or gizzard tissues. When a single oral dose of 0.5 g vomitoxin was administered to each of two lactating dairy cows, extremely low levels of vomitoxin (<4 ng/mg) were detected in the milk.

At the levels found in recent crop surveys, it was demonstrated that vomitoxin-contaminated wheat could be fed safely to livestock and poultry. As a result, feed regulatory officials have discontinued restrictions on the shipment and sale of contaminated wheat and health officials are no longer as concerned about vomitoxin residues in poultry products and milk. The "action level" for vomitoxin in winter wheat used in human foods has been raised to 2 mg/kg.

ARC research also has had an impact on wheat produced in other countries. In 1982 there were large areas of contaminated wheat in the U.S. midwest, and regulatory officials in that country have utilized ARC information in their assessment of the feed- and food-safety aspects of vomitoxin.

Fats and oils

The book *High and low erucic acid rapeseed oils* edited by Drs. Kramer, Sauer, and Pigden was published by Academic Press and has been well received. It is a complete summary of the past 20 yr of intensive nutritional, chemical, biochemical, and toxicological research which evaluated the safety of rapeseed (canola) oil and other vegetable oils, and it details much of the work carried out at ARC. Scientists from the ARC's rapeseed oil nutrition group contributed 5 of 22 chapters.

Major documents were prepared for Agriculture Canada in support of the Department's petition to the U.S. Food and Drug Administration (FDA) to obtain generally-recognized-as-safe (GRAS) status for canola oil. This project was started in 1979. GRAS status is enjoyed by all the other major vegetable oils, and because many countries adopt the U.S. FDA regulations, the lack of such status was restricting the trade and use of Canadian canola oil. When awarded, GRAS status will greatly improve international recognition of canola oil as a safe and nutritious product.

Recent reports claimed that the dietary requirements of lipotropic factors, such as methionine and choline, changed with increasing fat content in the diet. The data called into question the research that had been done on the cardiopathogenicity of vegetable oils. A thorough reevaluation of the effects of these two lipotropic factors showed that growth improved when additional methionine was fed to rats, but there was no effect on the incidence of myocardial necrosis. Therefore, the conclusions drawn from previous toxicological evaluations of vegetable oils remain valid.

A separation method was developed to isolate all lipid components on the same aliquot of a sample using the principle of three-directional thin-layer chromatography. Previously, separations required at least two complementary techniques to resolve all lipid classes and as a result the proportion of the lipid classes relative to each other was not maintained. The new method is highly sensitive, quick, and applicable to all biological samples.

A study was initiated to determine whether altering the fat component of the sow's diet affects the developing fetus. Sows are being fed a diet containing an oil high in polyunsaturated fatty acids, a tallow blend which is high in saturated fatty acids, or a no-fat control. Samples are being obtained at 57, 86, and 110 days of gestation to assess whether the maternal diet has affected fetal growth and composition.

PUBLICATIONS

Research

Ainsworth, L.; Lachance, R.; Labrie, F. 1983. Effects of progestagen treatments and PMSG on the induction of the preovulatory LH discharge in ewes. Anim. Reprod. Sci. 5:281-286.

Ainsworth, L.; Shrestha, J. N. B. 1983. Effect of type of intravaginal progestagen treatment on estrous response and reproductive performance of ewes. Theriogenology 19:869-875.

Akbar, M. K.; Gavora, J. S.; Friars, G. W.; Gowe, R. S. 1983. Composition of eggs by commercial size categories: Effects of genetic group, age and diet. Poult. Sci. 62:925-933.

Akhtar, M. H. 1983. Metabolism of fenvalerate by chicken liver homogenate. J. Agric. Food Chem. 31:1080-1083.

Atwal, A. S. 1983. Effects of preserving alfalfa as formic acid treated silage, wilted silage, and as hay in large round bales on chemical composition, recovery of nutrients, digestibility and heifer growth. Can. J. Anim. Sci. 63:925-937.

Batra, T. R.; McAllister, A. J. 1983. Incidence of subclinical and clinical mastitis in pureline and crossline dairy cattle. Can. J. Anim. Sci. 63:773-780.

Batra, T. R.; McAllister, A. J.; Chesnais, J. P.; Darisse, J. P. F.; Emsley, J. A. B.; Lee, A. J.; Roy, G. L.; Vesely, J. A.; Winter, K. A. 1983. Comparison of heifer reproduction traits of the daughters of several sire groups. Can. J. Anim. Sci. 63:269-278.

Batra, T. R.; McAllister, A. J.; Lee, A. J.; Lin, C. Y.; Roy, G. L.; Vesely, J. A.; Wauthy, J.; Winter, K. A. 1983. Body weights and dimensions of pureline and crossline heifers of the Canadian dairy cattle breeding project. Can. J. Anim. Sci. 63:511-522.

Cave, N. A. G. 1983. Glycine- and fatty-acid-induced restriction of feed intake: Effects on body weights and hatching egg production of broiler breeders restricted from day of hatching. Poult. Sci. 62:125-132.

Chambers, J. R.; Fortin, A.; Grunder, A. A. 1983. Relationships between carcass fatness and feed efficiency and its component traits in broiler chickens. Poult. Sci. 62:2201-2207.

El-Banna, A. A.; Hamilton, R. M. G.; Scott, P. M.; Trenholm, H. L. 1983. Nontransmission of deoxynivalenol (vomitoxin) to eggs and meat in chickens fed deoxynivalenol-contaminated diets. J. Agric. Food Chem. 31:1381-1384.

Erfle, J. D.; Mahadevan, S.; Teather, R. M.; Sauer, F. D. 1983. The performance of lactating cows fed urea-treated corn silage in combination with soybean or fishmeal containing concentrates. Can. J. Anim. Sci. 63:191-199.

Fairfull, R. W.; Garwood, V. A.; Spencer, J. L.; Gowe, R. S.; Lowe, P. C. 1983. The effects of geographical area, management, and lymphoid leukosis infection on adult performance in egg stocks of chickens. Poult. Sci. 62:2360-2370.

Fairfull, R. W.; Gowe, R. S.; Emsley, J. A. B. 1983. Diallel cross of six long-term selected Leghorn strains with emphasis on heterosis and reciprocal effects. Br. Poult. Sci. 24:133-158.

Farnworth, E. R. 1983. The composition of diets used in rapeseed oil feeding trials. Pages 315-333 *in* Kramer, J. K. G.; Sauer, F. D.; Pigden, W. J., eds., High and low erucic acid rapeseed oils. Academic Press, New York.

Farnworth, E. R.; Hamilton, R. M. G.; Thompson, B. K.; Trenholm, H. L. 1983. Liver lipid levels in White Leghorn hens fed diets that contained wheat contaminated by deoxynivalenol (vomitoxin). Poult. Sci. 62:832-836.

Farnworth, E. R.; Kramer, J. K. G. 1983. The effect of dietary fatty acids on growth and carcass composition in the rat. Nutr. Rep. Int. 27:799-809.

Farnworth, E. R.; Kramer, J. K. G.; Corner, A. H.; Thompson, B. K. 1983. The methionine and choline status of rat diets and their effects on nutrition and myocardial lesions. J. Nutr. 113:2442-2454.

Farnworth, E. R.; Kramer, J. K. G.; Jones, J. D.; Thompson, B. K.; Corner, A. H. 1983. The effect of commercial processing on the nutritional and cardiopathological quality of low erucic acid rapeseed oil. Can. Inst. Food Sci. Technol. J. 16:111-115.

Farnworth, E. R.; Trenholm, H. L. 1983. The metabolism of the mycotoxin zearalenone and its effects on the reproductive tracts of young male and female pigs. Can. J. Anim. Sci. 63:967-975.

Fiser, P. S.; Fairfull, R. W. 1983. Effects of changes in photoperiod on freezability of ram spermatozoa. Cryobiology 20:684-689.

Fortin, A.; Friend, D. W.; Sarkar, N. K. 1983. A note on the chemical composition of carcasses from Yorkshire boars and barrows. Can. J. Anim. Sci. 63:711-714.

Fortin, A.; Grunder, A. A.; Chambers, J. R.; Hamilton, R. M. G. 1983. Live and carcass characteristics of four strains of male and female geese slaughtered at 173, 180 and 194 days of age. Poult. Sci. 62:1217-1223.

Fortin, A.; Hoskins, V. E.; Sim, D. W. 1983. Regional characteristics of hog carcasses in Canada—A survey conducted in the spring 1981. Can. J. Anim. Sci. 63:551-561.

Fraser, D.; Sibbald, I. R. 1983. The effects of precision feeding on the behaviour of adult cockerels. Poult. Sci. 62:2224-2226.

Friend, D. W.; Kramer, J. K. G.; Fortin, A. 1983. Effect of age, sex and strain on the fatty acid composition of goose muscle and depot fats. J. Food Sci. 48:1442-1444.

Friend, D. W.; Trenholm, H. L.; Fiser, P. S.; Thompson, B. K.; Hartin, K. E. 1983. Effect of dam performance and fetal development of deoxynivalenol (vomitoxin) contaminated wheat in the diet of pregnant gilts. Can. J. Anim. Sci. 63:689-698.

Gavora, J. S.; Chesnais, J.; Spencer, J. L. 1983. Estimation of variance components and heritability in populations affected by disease: Lymphoid leukosis in chickens. Theor. Appl. Genet. 65:317-332.

Gavora, J. S.; Spencer, J. L. 1983. Breeding for immune responsiveness and disease resistance. Anim. Blood Groups Biochem. Genet. 14:159-180.

Gill, D. V.; Robertson, H. A.; Betz, T. W. 1983. *In vivo* estrogen synthesis by the developing chicken (*Gallus gallus*) embryo. Gen. Comp. Endocrinol. 49:176-186.

Grunder, A. A. 1982. Uterine adenosine triphosphatase in relation to shell quality. Poult. Sci. 62:512-518.

Grunder, A. A.; Hollands, K. G.; Tsang, C. P. W. 1983. Plasma estrogen, calcium and shell quality in two strains of White Leghorns. Poult. Sci. 62:1294-1296.

Grunder, A. A.; Lefkovitch, L. P.; Chambers, J. R.; Gavora, J. S. 1983. Blood plasma and production traits in commercial broiler parent stocks. Can. J. Anim. Sci. 63:247-250.

Hackett, A. J.; Hidiroglou, M. 1983. Effects of PMSG on progesterone levels of ewes treated with fluorogestone acetate or prostaglandin. Anim. Reprod. Sci. 6:191-197.

Heaney, D. P.; Shrestha, J. N. B.; Peters, H. F. 1983. Effects of post-weaning protein regimens and urea on the performance of intensively reared lambs. Can. J. Anim. Sci. 63:631-641.

Hidiroglou, M. 1982. Selenium in the ruminant genital system and mammary glands: A review. Ann. Rech. Vet. 13:133-141.

Hidiroglou, M. 1983. Blood plasma minerals and vitamins and acid base status of sheep raised under fluctuating or constant environment. J. Dairy Sci. 66:67-72.

Hidiroglou, M.; Proulx, J. 1983. Effect on calf growth and blood composition of prepartum injection of vitamin D_3 or 25-hydroxyvitamin D_3 to beef heifers. Can. J. Anim. Sci. 63:251-254.

Hidiroglou, M.; Thompson, B. K. 1983. The effect of turn-out to pasture on blood plasma iron concentrations in beef cattle. Livest. Prod. Sci. 10:83-87.

Ivan, M.; Ihnat, M.; Veira, D. M. 1983. Solubility and flow of calcium, magnesium and phosphorus in the digestive tract of sheep given maize or alfalfa silages. Anim. Feed Sci. Technol. 9:131-142.

Ivan, M.; Ihnat, M.; Veira, D. M. 1983. Flow and soluble proportions of zinc, manganese, copper and iron in the gastrointestinal tract of sheep fed corn or alfalfa silages. Can. J. Anim. Sci. 63:163-171.

Ivan, M.; Veira, D. M.; Hidiroglou, M. 1982. The effects of thiosalicylic and hydroxyethylethylenediaminetriacetic acids on the absorption and excretion of ^{54}Mn and ^{65}Zn in the duodenally dosed sheep. Can. J. Physiol. Pharmacol. 60:1514-1518.

Jenkins, K. J. 1983. Distribution of selenium. Pages 10-35 *in* Selenium in nutrition. National Academy of Sciences, National Academy Press, Washington, D.C.

Jenkins, K. J.; Emmons, D. B. 1983. Fortification of calf milk replacers with amino acids in free form or plastein-bound. Can. J. Anim. Sci. 63:893-903.

Jenkins, K. J.; Emmons, D. B. 1983. Inhibitory effect of certain fatty acids, chelating agents and other substances on chymosin clotting of skim milk. J. Dairy Sci. 66:719-726.

Kelleher, C. A.; Ivan, M.; Lamand, M.; Mason, J. 1983. The absorption of labelled molybdenum compounds in sheep fitted with re-entrant cannulae in the ascending duodenum. J. Comp. Pathol. 93:83-92.

Khan, S. U.; Akhtar, M. H. 1983. *In vitro* release of bound (nonextractable) atrazine residues from corn plants by chicken liver homogenate and bovine rumen liquor. J. Agric. Food Chem. 31:641-644.

Khan, S. U.; Akhtar, M. H. 1983. Photodecomposition of chlorothalonil in benzene. Pestic. Sci. 14:354-358.

Kim, K. I.; Elliot, J. I.; Bayley, H. S. 1983. Oxidation of an indicator amino acid by young pigs receiving diets with varying levels of lysine or threonine and an assessment of amino acid requirement. Br. J. Nutr. 50:391-399.

Kramer, J. K. G.; Fouchard, R. C.; Farnworth, E. R. 1983. A complete separation of lipids by three-directional thin-layer chromatography. Lipids 18:896-899.

Kramer, J. K. G.; Sauer, F. D. 1983. Results obtained with feeding low erucic acid rapeseed oils and other vegetable oils to rats and other species. Pages 413-474 *in* Kramer, J. K. G.; Sauer, F. D.; Pigden, W. J., eds., High and low erucic acid rapeseed oils. Academic Press, New York.

Kramer, J. K. G.; Sauer, F. D. 1983. Cardiac lipid changes in rats, pigs, and monkeys fed high fat diets. Pages 475-513 *in* Kramer, J. K. G.; Sauer, F. D.; Pigden, W. J., eds., High and low erucic acid rapeseed oils. Academic Press, New York.

Langford, G. A.; Marcus, G. J.; Batra, T. R. 1983. Seasonal effects of PMSG and number of inseminations on fertility of progestagen-treated sheep. J. Anim. Sci. 57:307-312.

Lin, C. Y.; Batra, T. R.; McAllister, A. J.; Darisse, J. P. F.; Lee, A. J.; Roy, G. L.; Vesely, J. A.; Winter, K. A. 1983. Differences between sire groups in body measurements and body weight changes of lactating cows. Can. J. Anim. Sci. 63:27-37.

Mahadevan, S.; Teather, R. M.; Erfle, J. D.; Sauer, F. D. 1983. Effect of formaldehyde treatment of soybean meal on rates of protein degradation and microbial protein concentration in the bovine rumen. Can. J. Anim. Sci. 63:181-190.

Miller, D. J.; Young, J. C.; Trenholm, H. L. 1983. *Fusarium* toxins in field corn. I. Time course of fungal growth and production of deoxynivalenol and other mycotoxins. Can. J. Bot. 61:3080-3087.

Neish, G. A.; Farnworth, E. R.; Greenhalgh, R.; Young, J. C. 1983. Observations on the occurrence of *Fusarium* species and their toxins in corn in eastern Ontario. Can. J. Plant Pathol. 5:11-16.

Reid, W. S.; Ivan, M.; Buckley, D. J. 1983. An automatic digesta sampler for sheep. J. Agric. Eng. Res. 28:79-87.

Sarkar, N. K.; Lodge, G. A.; Williams, C. J.; Elliot, J. I. 1983. The effects of undernutrition of suckled pigs on subsequent growth and body composition after nutritional rehabilitation. J. Anim. Sci. 57:34-42.

Sauer, F. D.; Kramer, J. K. G. 1983. The problems associated with the feeding of high erucic acid rapeseed oils and some fish oils to experimental animals. Pages 253-292 in Kramer, J. K. G.; Sauer, F. D.; Pigden, W. J., eds., High and low erucic acid rapeseed oils. Academic Press, New York.

Sauer, F. D.; Kramer, J. K. G. 1983. The metabolism of docosenoic acids in the heart. Pages 335-354 in Kramer, J. K. G.; Sauer, F. D.; Pigden, W. J., eds., High and low erucic acid rapeseed oils. Academic Press, New York.

Schang, M. J.; Sibbald, I. R.; Hamilton, R. M. G. 1983. Comparison of two direct bioassays using young chicks and two internal indicators for estimating the metabolizable energy content of feedingstuffs. Poult. Sci. 62:117-124.

Shrestha, J. N. B.; Ainsworth, L.; Heaney, D. P. 1983. Influence of breed on reproductive performance of ewes treated with fluorogestone acetate-impregnated intra-vaginal sponge and pregnant mare's serum gonadotrophin during the breeding season. Can. J. Anim. Sci. 63:1-6.

Shrestha, J. N. B.; Fiser, P. S.; Langford, G. A.; Heaney, D. P. 1983. Influence of breed, birth date, age and body weight on testicular measurements of growing rams maintained in a controlled environment. Can. J. Anim. Sci. 63:835-847.

Shrestha, J. N. B.; Peters, H. F.; Heaney, D. P. 1983. Inheritance of weights of lambs reared artificially or with their dams. Can. J. Anim. Sci. 63:263-268.

Sibbald, I. R.; Elliot, J. I.; Coté, M. 1983. Comparison of bioavailable energy values of diets measured with poultry and swine. Anim. Feed Sci. Technol. 8:191-196.

Sibbald, I. R.; Morse, P. M. 1983. The effects of feed input and excreta collection time on estimates of metabolic plus endogenous energy losses in the bioassay for true metabolizable energy. Poult. Sci. 62:68-76.

Sibbald, I. R.; Morse, P. M. 1983. Effects of the nitrogen correction and of feed intake on true metabolizable energy values. Poult. Sci. 62:138-142.

Sibbald, I. R.; Morse, P. M. 1983. Provision of supplemental feed and the application of a nitrogen correction in bioassays for true metabolizable energy. Poult. Sci. 62:1587-1605.

Sibbald, I. R.; Morse, P. M. 1983. Recent developments in the bioassay for true metabolizable energy in poultry feedingstuffs. Pages 239-242 *in* Robards, G. E.; Packham, R. G., eds., Feed information and animal production. Commonw. Agric. Bur., Slough, England.

Spencer, J. L.; Gilka, F.; Gavora, J. S. 1983. Detection of lymphoid leukosis virus infected chickens by testing for group-specific antigen or virus in feather pulp. Avian Pathol. 12:85-99.

Thompson, B. K.; Grunder, A. A.; Hamilton, R. M. G.; Hollands, K. G. 1983. Repeatability of egg shell quality measurements within individual hens. Poult. Sci. 62:2309-2314.

Thompson, J. N.; Hidiroglou, M. 1983. Effect of large oral and intravenous doses of vitamin D_2 and D_3 or vitamin D in milk. J. Dairy Sci. 66:1638-1643.

Trenholm, H. L.; Cochrane, W. P.; Cohen, H.; Elliot, J. I.; Farnworth, E. R.; Friend, D. W.; Hamilton, R. M. G.; Standish, J. F.; Thompson, B. K. 1983. Survey of vomitoxin contamination of 1980 Ontario white winter wheat crop: Results of survey and feeding trials. J. Assoc. Off. Anal. Chem. 66:92-97.

Tsang, C. P. W.; Grunder, A. A. 1983. Effect of active immunization against estradiol on egg shell quality. Poult. Sci. 62:1297-1304.

Uhthoff, H. K.; Finnegan, M.; Hidiroglou, M. 1982. Epiphysiolysis, a possible cause of limb deformities in lambs. Ann. Rech. Vet. 13:237-244.

Veira, D. M.; Fortin, A.; Ivan, M.; Butler, G.; Proulx, J. G. 1983. Performance of Hereford × Shorthorn bulls and steers raised in northern Ontario and fed different levels of grass silage and high moisture barley. Can. J. Anim. Sci. 63:861-870.

Veira, D. M.; Ivan, M. 1982. The effect of dietary protein on digestion and fermentation in the gastrointestinal tract of sheep. Ann. Rech. Vet. 13:213-220.

Veira, D. M.; Ivan, M.; Jui, P. Y. 1983. Rumen ciliate protozoa: Effects on digestion in the stomach of sheep. J. Dairy Sci. 66:1015-1022.

Vesely, J. A.; McAllister, A. J.; Lee, A. J.; Batra, T. R.; Darisse, J. P. F.; Roy, G. L.; Winter, K. A. 1982. Evaluation of cow reproduction in the pureline foundation phase of the Canadian national dairy cattle breeding project. J. Dairy Sci. 66:867-873.

Whiting, R.; Owen, B. D.; Elliot, J. I.; Beames, R. M. 1983. Porcine immunoglobin-fortified milk replacers for newborn low-birthweight pigs. Can. J. Anim. Sci. 63:993-996.

Zhang, L.-Z.; Akhtar, M. H.; Khan, S. U. 1983. Reaction of diazomethane with chlorothalonil. Chemosphere 12:951-954.

Miscellaneous

Atwal, A. S.; Sauer, F. D.; Erfle, J. D. 1983. Quality of alfalfa hay stored in large round bales. Canadex 121.61.

Fitzpatrick, D. W.; Trenholm, H. L. 1983. Are mycotoxins eating away your profits? /Les mycotoxines diminuent-elles vos profits? Can. Agric. 29(1):35-39.

Hackett, A. J.; Robertson, H. A.; Penner, P.; McLaughlin, G. R. 1983. Comparison of two methods of estrus synchronization in commercial sheep flocks. Can. Agric. 28(4):26-27.

Jones, S. D. M.; Fortin, A.; Haworth, C. R. 1983. Pork carcass grading using electronic probes. Information for Industry Personnel. Ont. Min. Agric. Food., Univ. Guelph. Agdex 444/844. 1 p.

Jenkins, K. J.; Emmons, D. B. 1983. Supplementing calf milk replacers with amino acids. Canadex 401.68.

Jenkins, K. J.; Emmons, D. B. 1983. Tolerance of calves to oxidized fat in milk replacer. Canadex 401.68.

Kramer, J. K. G.; Sauer, F. D.; Pigden, W. J. 1983. High and low erucic acid rapeseed oils. Academic Press, New York. 582 pp.

Langford, G. A. 1983. Artificial insemination for sheep. Canadex 430.36.

Nagai, J.; McAllister, A. J. 1982. Mating systems designed to capitalize on heterosis in dairy cattle. Can. Agric. 28(4):30-33.

Sibbald, I. R. 1983. The current status of TME. Pages 286-293 *in* Farrell, D. J.; Vohra, P., eds. Recent advances in animal nutrition in Australia. Publ. Univ. New England, N.S.W., Australia.

Sibbald, I. R. 1983. The TME system of feed evaluation/La méthode d'évaluation des aliments par le calcul de l'énergie metabolisable vraie (ÉMV). Res. Branch/Dir. gén. rech., Agric. Can., Ottawa, Ont. Publ. 1983-20E/20F. 89 pp.

Sibbald, I. R.; Ho, S. K. 1983. Changes in Canadian feed legislation. Pages 206-215 *in* Farrell, D. J.; Vohra, P., eds. Recent advances in animal nutrition in Australia. Publ. Univ. New England, N.S.W., Australia.

Smith, E. G.; Howell, W. E.; Lee, G. E.; Shrestha, J. N. B. 1983. L'économie de la production intensive du mouton. Cent. rech. zootec., Agric. Can., Ottawa, Ont. Publ. 1983-7F. 73 pp.

Research Centre London, Ontario

PROFESSIONAL STAFF

H. V. Morley, B.Sc., Ph.D.	Director
J. A. Coleman	Administrative Officer
D. E. H. Drew,[1] B.Sc., M.L.S.	Librarian

Mode of Action of Selected and Potential Insect Control Agents

W. Chefurka, B.Sc., M.Sc., Ph.D.	Section Head; Biochemistry
E. J. Bond, B.S.A., M.Sc., Ph.D.	Fumigation—toxicology
T. Dumas, D.C.E., M.Sc.	Analytical chemistry
R. M. Krupka, B.A., M.A., Ph.D.	Biochemistry
T. T. Lee, B.Sc., Ph.D.	Plant biochemistry and tissue culture
T. Nagai, M.E., M.Sc., D.Sc.	Neurophysiology
E. B. Roslycky, B.Sc., M.Sc., Ph.D.	Microbiology
A. N. Starratt, B.Sc., Ph.D., F.C.I.C.	Chemistry—attractants and repellents
R. W. Steele, B.Sc., Ph.D.	Neurochemistry
A. Vardanis, B.Sc., M.Sc., Ph.D.	Biochemistry

Mode of Action of Selected and Potential Plant-Pathogen Control Agents

E. W. B. Ward, B.Sc., M.Sc., Ph.D.	Section Head; Plant pathology—phytoalexins
D. A. Cuppels, B.A., M.S., Ph.D.	Phytobacteriology—microbial physiology
G. Lazarovits, B.Sc., M.Sc., Ph.D.	Plant pathology—fungicides
C. Madhosingh, B.S.A., M.A., Ph.D.	Microbial biochemistry and pathology
D. M. Miller, B.Sc., M.Sc., Ph.D.	Biophysical chemistry—fungicide selectivity
A. Stoessl, B.Sc., Ph.D., F.C.I.C.	Organic chemistry—phytoalexins and mycotoxins
G. A. White, B.A., M.Sc., Ph.D.	Biochemistry—fungicides

Soil Pesticides

C. R. Harris, B.A., M.A., Ph.D.	Section Head; Insect toxicology
B. T. Bowman, B.S.A., M.Sc., Ph.D.	Soil physical chemistry
R. A. Chapman, B.Sc., M.Sc., Ph.D.	Analytical organic chemistry
D. G. R. McLeod, B.S.A., M.S., Ph.D.	Physiology
J. R. Robinson, B.S.A., M.S.A., Ph.D., F.C.I.C.	Chemistry—radioisotopes and photodynamic insecticides
J. H. Tolman, B.Sc., M.Sc., Ph.D.	Applied entomology
A. D. Tomlin, B.A., M.Sc., Ph.D.	Pesticide ecology
C. M. Tu, B.Sc., M.Sc., Ph.D.	Microbiology

Departures

J. Giesbrecht,[1] B.A., B.L.S. Deceased May 1983	Library Area Coordinator (Ont.)
J. R. W. Miles, B.Sc. Retired June 1983	Analytical chemistry

VISITING SCIENTISTS

J. Holenstein, Dipl. Natw., Ph.D. 1982–1983	Biosynthesis of phytoalexins
K. R. Jennings, B.Sc., Ph.D. 1981–1983	Pesticide physiology
G. J. P. Singh, B.Sc., M.Sc., Ph.D. 1982–1984	Biochemistry—pesticide physiology
M. D. Zhou, M.S. 1981–1983	Plant physiology
F. Rutherford, B.Sc., Ph.D. 1983–	Plant pathology

Graduate student

D. Classen, M.Sc. 1981–	Plant pathology

---

[1] Seconded from Libraries Division, Finance and Administration Branch.

INTRODUCTION

This report summarizes highlights of research carried out during 1983 at the London Research Centre in support of departmental objectives in environmental quality and crop protection. The Centre was established in 1951 to investigate the problems created by the introduction of synthetic organic pesticides. Present research programs reflect the current health and environmental concerns regarding the agricultural use of pesticides by concentrating research efforts in integrated pest management (IPM) and environmental toxicology.

The IPM objective comprises four research activities. The pest management activity is aimed at developing IPM procedures, including biological control, for agriculturally and economically important insect pests. Research on stored products is directed toward the investigation of environmental and insect resistance problems and the development of more efficient fumigation procedures leading to a minimum of pesticide residues. The third activity concerns research on alternative pest control strategies. Studies on insects are aimed at identifying specific areas for attack so that pest control in the future will not rely upon the use of broad-spectrum toxicants. Research on natural plant defense mechanisms in disease-resistant and susceptible agriculturally important crops has the objective of using natural defense mechanisms by chemical manipulation or in the breeding of resistant varieties. The last activity under the IPM objective concerns research on systemic fungicides. Studies are carried out on the efficacy of systemic fungicides and on the plant-pathological, biochemical, biophysical, and structural parameters of fungicide activity and resistance.

Research on environmental toxicology has three areas of activity. The first deals with the effect of pesticides on nontarget soil invertebrates and agriculturally important soil microorganisms. The second is concerned with the determination of the behavior, persistence, and environmental fate of pesticides and their movement through the environment. The third is concerned with establishing the mode of action of growth regulators and toxicants by carrying out studies on insects and plants related to vital processes of growth and development.

The Centre was saddened by the sudden death in May of Mrs. Jo Giesbrecht, Library Area Coordinator for southwestern Ontario. Mrs. Giesbrecht was seconded from the Libraries Division, Finance and Administration Branch.

This report records only the highlights of our accomplishments for 1983; more detailed information can be obtained from the publication titles listed at the end of this report. Copies of this report, reprints of publications, and further information are available on request from the Research Centre, Agriculture Canada, University Sub Post Office, London, Ont. N6A 5B7.

H. V. Morley
Director

INTEGRATED PEST MANAGEMENT

Biological control of the onion maggot

Further progress was made on the feasibility studies aimed at incorporating biological control using parasites and predators into an integrated control program.

As a result of continuing refinement and modification, the rearing method for the staphylinid beetle *Aleochara bilineata* has progressed to the point where 6–7 person-hours are producing 14 000 *A. bilineata* beetles each week. Approximately 75% are reared under diapausing conditions and are being stored, for future release, as first-instar larvae within the host puparium. The remainder are utilized for studies of biology and toxicology or for maintenance of the stock culture.

Laboratory studies showed longest survival and greatest egg production by *A. bilineata* at 15°C. In contrast to *Aphaereta pallipes*, which proved an effective parasite over only a relatively restricted temperature range, *Aleochara bilineata* successfully parasitized 90% of presented onion maggot pupae at temperatures ranging from 15 to 30°C. First-instar *A. bilineata* larvae were able to move through organic soil at least 28 cm horizontally or 15 cm vertically to locate and successfully parasitize host pupae.

Microplots set up among pickling onions growing in organic soil at the Fanshawe Field Station established that the presence of *A. bilineata* in a population numbering 24/m^2 reduced damage by 21.4%; increasing the population to 96/m^2 reduced onion damage by 47.6%.

Entomophthora muscae is an effective pathogen of the house fly and onion root maggots. A culture method was developed and 12 cultures were chosen from 88 isolates of dead flies to determine their relative potency to selected dipteran species. *E. muscae* is most active under cool and moist conditions. These are the same conditions under which fungus diseases of crops develop. Little information is available as to the toxicity of pesticides to *E. muscae*; therefore 20 insecticides, 6 herbicides, and 10 fungicides were tested. Of these, ioxynil, anilazine, captofol, and chlorothalonil were most toxic.

Monitoring studies

Analysis of Masner traps stationed at various heights reveals that flight of *A. bilineata* is mainly confined to levels below 0.46 m. Catches in traps above this height were 17% of those below it. Pitfall traps were not nearly as efficient in trapping *A. bilineata* adults as Masner traps.

Populations of the onion maggot on the Thedford–Grand Bend marsh were again monitored throughout the growing season. Collected information was passed on to growers in the newsletter of the Ontario Ministry of Agriculture and Food (OMAF). The second year of a monitoring program for the carrot rust fly revealed very low populations of this pest. A monitoring program using carrot plugs was initiated for the carrot weevil; the pest was captured at all locations.

The weekly corn-borer-alert message sent to all OMAF offices in Ontario was continued and expanded. Information on the potential for damage by the variegated cutworm in tomatoes and peppers in Essex and Kent counties was added to the alert. This was made possible, in part, by cooperative projects with OMAF (Ridgetown) and H. J. Heinz, supported by the Ontario Vegetable Growers' Marketing Board and Ministry of the Environment, respectively.

Yellow pan traps continued to be the most effective method of assessing adult cabbage maggot populations. Cone traps with allylisothiocyanate were nearly as effective and both were superior to interception traps.

Toxicity-resistance studies

Twelve insecticides, five herbicides, and three fungicides were tested as commercial formulations for residual toxicity to the parasitoid *A. bilineata* at the highest recommended rate of application. No herbicide or fungicide tested proved toxic to the beetles. The pyrethroids permethrin, cypermethrin, fenvalerate, and fluvalinate all appeared quite safe to *A. bilineata* individuals not directly sprayed by insecticide; deltamethrin was moderately toxic. Of the currently recommended insecticides, dibrom and malathion proved nontoxic to *A. bilineata* at suggested rates; diazinon was moderately toxic and parathion and chlorpyrifos proved most toxic. The relative residual toxicity of several insecticides was tested on organic soil and Plainfield sand; all proved more toxic on Plainfield sand.

In insecticide resistance studies, tests done on cabbage maggots from Manitoba and Newfoundland showed no evidence of development of resistance to organophosphorus or carbamate insecticides. An Ontario Colorado potato beetle strain showed no evidence of development of significant resistance to organophosphorus and carbamate insecticides, but tests on strains from New Brunswick indicated development of high-level resistance to carbofuran in one strain. Onion maggots in Ontario and New York State continued to show low-level resistance to organophosphorus and carbamate insecticides. Laboratory studies indicated that there were substantial differences in toxicity of several permethrin isomers to insecticide-susceptible house flies and that in the Ontario strain of pyrethroid-resistant house flies, levels of resistance to the various permethrin isomers were markedly different. Enhanced oxidative metabolism was determined to be the major factor involved in development of house fly resistance to the pyrethroids in southwestern Ontario. A laboratory and field study to evaluate the effectiveness of cypermethrin for control of flies and cockroaches in buildings using an insecticide-impregnated felt-tip pen as the applicator gave promising results.

A bioassay system developed was found to be suitable for comparative testing of selected photosensitizing materials (dyes) using larvae of the fly *Musca domestica* Linnaeus which is a serious pest in stables and feedlots. The Guelph strain which has developed high resistance toward the usual classes of insecticides has been shown to be fully susceptible to a photodynamic system (erythrosine plus light). Evidence was collected that implicates an excited electronic state of oxygen as the main toxic principle in this photodynamic system; full protection of the larvae is provided by incorporation of a singlet-oxygen quencher in the diet medium.

Evaluation of pesticides

In Ontario, application of insecticides for corn rootworm control probably represents the largest use against any one insect pest. To obtain comparative persistence data, field microplot trials were set up using 10 insecticides that are registered or being evaluated for corn rootworm control.

It is generally assumed that insecticide residues must remain in the soil at biologically active levels for approximately 8 wk to provide effective corn rootworm control. CGA 73102, chloethocarb, and chlorfenvinphos all declined to less than 2% of the initial application in 8 wk. The remaining insecticides (chlorpyrifos, fonofos, phorate, carbofuran, disulfoton, terbufos, and isofenphos) appeared to be sufficiently persistent (12–66% of the initial application remaining after 8 wk) to meet this guideline. After 20 wk, no residues of CGA 73102, chloethocarb, or carbofuran were detectable in the soil; residues of chlorfenvinphos, chlorpyrifos, fonofos, phorate, disulfoton, and terbufos were all less than 3% of the initial application. Isofenphos was the most persistent of the 10 insecticides.

After laboratory germination tests showed aldrin, isofenphos, chlorfenvinphos, chlorpyrifos, diflubenzuron, flucarbenzuron, permethrin, and cypermethrin to be relatively safe to onions, radishes, and summer turnips, field microplot trials were carried out during both 1982 and 1983 to evaluate field effectiveness of seed dressings for root maggot control.

Although both the synthetic pyrethroids permethrin and cypermethrin and the growth regulators diflubenzuron and flucarbenzuron did reduce root maggot damage in most crops, the degree of control achieved was not satisfactory at the tested rates of active ingredients (a.i.) (10–30 g/kg seed). Similarly, the organophosphorus (OP) insecticides isofenphos, chlorfenvinphos, and chlorpyrifos did not provide reliable control of root maggot damage at the lower tested a.i. rates of 10 and 15 g/kg seed. At the higher a.i. rates of 20 and 25 g/kg seed, however, all three OPs provided generally acceptable control of root maggot damage in all tested crops except summer turnips.

Harvest samples showed no detectable residues of any insecticide in dry yellowseed onions. Traces of isofenphos (0.021 ppm) and chlorpyrifos (0.046 ppm) were recorded in pickling onions; only isofenphos (0.0088 ppm) was detected in bunching onions. Residues of all three OPs were, however, recorded in radishes harvested 5 wk after planting; chlorpyrifos residues were highest at 0.1 ppm.

Crop loss studies

Within the broad framework of integrated pest management there is a need to generate hard data regarding crop losses by the total pest complex to serve as a basis for decision making. With support from the Ontario Ministry of the Environment, work continued at London on obtaining solid data on crop losses that would occur in the absence of adequate pest control programs.

Crop loss studies were initiated on tomatoes and cabbages and continued on onions to complete the 3rd yr of loss studies. Total crop loss for tomatoes was 81.6% (insect loss negligible in 1983), equivalent to a loss of $3623/ha. Cabbage crop loss was 85.7% (disease loss negligible in 1983), equivalent to a loss of $1997/ha to the farmer. For onions the total crop loss was 100%, which translates to a loss of $6463/ha.

If the results of the 3-yr study on onions are averaged, uncontrolled insects, weeds, and diseases caused losses of 37.4, 100.0, and 26.2%, respectively.

Insect rearing

A vigorous insect rearing program is a vital component of integrated pest management research. Development of successful techniques for rearing potential biological control agents is a prerequisite for inundative field release. Many insecticide-resistant and -susceptible strains are maintained and made available to other laboratories.

Thirty-three separate strains of insects representing 24 individual species were processed through the rearing program in 1983; this number is an increase of five strains over 1982.

Over 25 000 beetles of *A. bilineata* were released during the summer so that their potential for control of the onion maggot could be examined. Eleven field cultures were received and allowed to emerge or held for screening tests. Fifty-seven separate shipments of insects were made to a variety of government, university, and commercial laboratories across the country.

STORED PRODUCTS

Investigations on the potential usefulness of modified atmospheres have indicated that living eggs of the European red mite can be eradicated from harvested apples in a reasonable length of time and at temperatures compatible with quality preservation procedures by appropriate manipulation of the atmosphere. Further tests are needed to define precise conditions for control that would be adaptable to modern storage regimes.

Studies on the corrosion of metals caused by the fumigant phosphine have indicated the reactions involved, the conditions that promote the reactions, and the effectiveness of certain inhibitors. This investigation has provided, for the first time, much-needed information on a problem of great concern to users of the fumigant.

A new gas chromatograph designed and produced by a new Canadian company has been adapted to the special needs of the pest control industry. It has been shown to be useful and sensitive for analysis of fumigants at the ultralow levels that are of concern for human health and also at the higher levels used for pest control. It is portable and has been found very useful both for laboratory and field projects. Tests and development of appropriate methods have demonstrated the potential usefulness of the instrument to the food storage and pest control industries and has thus opened up a new field of application for an international market.

In another investigation, sensitive techniques for studying low levels of carbon dioxide and desorption of methyl bromide from single insects has been developed.

ALTERNATIVE PEST CONTROL STRATEGIES

Plant diseases

As reported in 1982, compatible and incompatible reactions of etiolated soybean tissues with races of *Phytophthora megasperma* f. sp. *glycinea* can be differentiated as early as 3 h after inoculation by replacing the inoculum drops with L-Dopa solution. Oxidation of the substrate to the red dopaquinone is indicative of an incompatible reaction, whereas at compatible sites, no such reaction occurs. The mechanism of this reaction was explored using histochemical and ultrastructural techniques. In chemically fixed tissues, polyphenoloxidase (PPO), the enzyme that catalyzes this reaction, was localized within the chlorplasts of epidermal cells and the two adjoining cell layers but was not found in mesophyll cell chloroplasts. Reaction product was located within the chloroplast lamellae and in the large membrane-bound crystalline inclusions in the chloroplast stroma. The results quite conclusively implicate cell injury and death as the primary event that allows for the oxidation of L-Dopa applied to incompatibly reacting tissues.

The postulate that inoculation with a virulent or an avirulent race of a pathogen would induce, respectively, susceptibility or resistance to a subsequent inoculum by inducing a recognition event has been disproved using the soybean–*P. megasperma* f. sp. *glycinea* system. A reisolation procedure was developed that for the first time clearly distinguished mixtures of races after infection. Ongoing studies of the toxins produced by the bacterial blight of the soybean pathogen *Pseudomonas glycinea* continued. A second toxin has been isolated which was shown to be a small peptide, similar to a toxin produced by the pathogen of kidney beans. It was shown to be responsible for systemic symptoms in this disease, and like the kidney bean toxin is a potent inhibitor of ornithine carbaryl transferase.

The method developed in 1982 utilizing bacteriophages for rapid identification of the bacterial speck pathogen was tested in the field. The four bacteriophages highly specific for *P. syringae* pv. *tomato* (PT phages) were isolated from plant debris in Ontario tomato fields. These phages did not infect other bacterial pathogens of tomato or the saprophytic pseudomonads found in tomato fields. In field studies, *P. syringae* pv. *tomato* was isolated from every leaf lesion that was sensitive to the PT phages. Conversely, all lesions from which the pathogen was isolated were sensitive to the phages. Thus, phage sensitivity tests are a simple and effective means of rapidly identifying a tomato leaf lesion as bacterial speck; they should be of considerable diagnostic value for the plant pathologist.

The transformation of DNA obtained from the protoplasts of the zearalenone-producing fungus *Fusarium graminearum* into the protoplast of *F. culmorum*, a phytopathogenic isolate of the species that does not produce zearalenone, was demonstrated. Zearalenone was demonstrated in cultures developed from regenerated transformed protoplasts of *F. culmorum*. Zearalenone, a well-characterized mycotoxin produced by *F. graminearum*, afforded a relatively simple definitive chemical assay in this initial study to determine the expression of DNA transformation.

The structurally somewhat unusual marticins are known as the most potent of the naphthazirin phytotoxins produced by *Fusarium* species. Detailed nuclear magnetic resonance studies of the incorporation of ^{13}C-labeled acetates into the marticins have now verified the prediction that they are biosynthesized by the addition of a Krebs-cycle C_3 unit to the acetate/malonate-derived normal naphthazirin nucleus.

Cercospora arachidicola is a pathogen of peanut, a plant of considerable current interest as an alternative crop for southwestern Ontario's tobacco lands. The fungus has now been found, in the laboratory, to produce large amounts of the aflatoxin-related toxin dothistromin, together with smaller quantities of the aflatoxin-precursor averufin and large numbers of other related pigments still under investigation.

Insect pests

Research on insect pests is directed toward gaining an understanding of basic life processes peculiar to the insect so that methods of selective, specific control can be developed that do not rely upon broad-spectrum toxicants.

Research was carried out on the biochemical control mechanisms associated with the insect molt–intermolt cycle. Work was directed toward elucidation of the pattern of activity of the enzyme chitinase during the life cycle of the house fly.

Low levels of chitinase activity were found in homogenates of third-instar wandering larvae. Activity increased during pupation with a maximum in the middle of the pupal period, followed by a decrease toward the time of adult emergence. Molecular weight estimates of 42 000 and 120 000 were obtained for these enzymes. The smaller enzyme had higher specific activity. The relative activity of this group of enzymes seems to be under hormonal control, as injections of ecdysone to the larvae resulted in large activity increases. The molecular basis of this control is under investigation with the objective of developing specific pest controls that interfere with the molt–intermolt cycle.

Studies relating to control of levels of the important insect neuropeptide proctolin in the cockroach *Periplaneta americana* were continued. Although their significance to proctolinergic action is still unknown, several enzymes that can rapidly inactivate proctolin were found in the hemolymph of this insect. One of these is a post-proline-cleaving enzyme, which has an acidic pH optimum. These studies indicate that proctolin cannot be transported via the hemolymph unless it is protected in some manner from enzymatic degradation.

Methods developed for the determination of proctolin levels in various tissues demonstrated the presence of several other neuropeptides with myogenic activity.

The calcium antagonist diltiazem was active on both nerve and muscle preparations of the cockroach, having an effect similar to that seen with certain insecticides.

A novel experimental approach was devised to investigate the relationship between the specificity of the inner and outer substrate transfer sites in a choline carrier system. The results established that although only one substrate site is exposed in the carrier at one time, nevertheless the specificity is strikingly different on the two sides. This result indicates that an extensive reorganization of the carrier structure takes place as it shifts in orientation from one side of the membrane to the other.

ENVIRONMENTAL TOXICOLOGY

Effects of pesticides on nontarget organisms

Pesticides are rarely utilized in a pure form but are mixed with inert materials, such as solvents, diluents, dispersing agents, wetting agents, or water-soluble polymers. Inert materials are not without their effects on the physical or biological properties of the pesticides. A comparison of the effects of emulsifiable concentrate (EC) formulations of insecticides and of technical insecticides indicated that most of the EC formulations stimulated consumption of oxygen, and bacterial and fungal numbers, in 3 wk. No effect was observed on sulfur oxidation, or activities of the enzymes urease, dehydrogenase, and nitrogenase with formulated or nonformulated insecticides.

Soybean inoculated with thiram-resistant cultures of *Rhizobium japonicum* mutant had heavier dry matter and greater activities in fixation of N_2 than the plants inoculated with thiram-susceptible strains. Mutants resistant to high levels of thiram were obtained and further studies on stabilization of the mutants are in progress.

Environmental fate of pesticides

Work directed toward determining the persistence and movement of pesticides in the environment continued. The rapid disappearance of aldicarb from heavily watered versus dry mineral soil observed in the field in 1981 and 1982 appears to be largely due to leaching rather than the more rapid chemical degradation based on laboratory experiments. This finding, combined with the fact that aldicarb itself is a major component of the leachate and that appreciable leaching can occur with moderate amounts of water flow, suggests that use of aldicarb on mineral soil should be carefully monitored for groundwater contamination.

Results to date indicate that groundwater contamination from use of disulfoton on mineral soil is unlikely. The sulfoxide metabolite was the major cause for concern, it being quite water soluble, but results indicate that it is not formed in large amounts in the soil.

The effect of adsorbent concentration (soil: water ratio) on insecticide adsorption in sediment–water systems was examined. Recent literature reports have shown a dramatic increase in relative adsorption as the adsorbent concentration decreased. If this is true, the effect would greatly slow down the rate at which environmental pollutants are flushed from river–lake systems. In addition, this phenomenon would negate the use of centrifuges to separate the phases in adsorption experiments, since the equilibrium concentrations would be altered. Results showed that adsorbent concentration does not significantly affect insecticide adsorption. It is likely that reported anomalous effects are a result of small systematic pesticide losses, coupled with large relative errors.

A desorption technique, developed as a result of the work summarized above, has shown that much of the irreversibility (hysteresis) associated with pesticide adsorption–desorption phenomena can be ascribed to artifacts created by the centrifugation process. Although centrifugation does not affect the partitioning in primary-phase separation, it does seem to irreversibly alter the system toward subsequent desorption processes.

The adaptation of biological agents in the soil to the degradation of carbofuran was positively demonstrated for the first time. The ease and speed with which adaptation occurred in the laboratory were surprising. Previous treatment of a sandy loam soil with 10 ppm of carbofuran greatly decreased the persistence of subsequent treatments. Increased degradation rates for a variety of aryl- and oximinomethyl carbamates were observed in carbofuran-activated soil. Degradation rates of butylate, chlorpropham, and phorate were unaffected. Sterilizing, freezing, or drying the soil altered the activity, suggesting that adapted microorganisms were the active agents.

Pesticide toxicity and mode of action

Pyrazole carboxanilides have been shown to be potent antifungal agents for the control of rusts and smuts and to be especially effective for the control of *Rhizoctonia solani* in cotton. In a cooperative project with the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia, a large number of pyrazole carboxanilides were synthesized and tested for inhibition of the succinic dehydrogenase complex in mitochondria isolated from several species of plant-pathogenic fungi. Apart from providing new data on structural requirements for activity and for potential use in controlling plant disease, the most significant finding was the effect of specific structural modification on inhibition of the enzyme complex from different fungi. Earlier conclusions about structural requirements for activity have to be revised, since activity in a series of *N*-methylpyrazole carboxanilides is greater when the methyl and carboxanilido groups are substituted across a formal single rather than a formal double bond.

Research on the mode of action of glyphosate continued. Glyphosate-treated plants had a high rate of conjugation and oxidation of indole-3-acetic acid (IAA) and a significantly lower free IAA level than the control. Comparison studies with glyphosate and related compounds and with tolerant and susceptible plant species revealed that the induced increase in IAA metabolism was correlated with the inhibition of growth, the decrease of ethylene production, and the release of lateral buds from apical dominance in susceptible plants. As IAA is a natural plant hormone and is known to be involved in these and various other aspects of plant growth and development, the finding of the effect of glyphosate on IAA metabolism provides a direct link between glyphosate action and plant responses.

Experiments with glyphosate also revealed that the natural rate of IAA metabolism differed markedly between the glyphosate-tolerant and -susceptible plant species, and was related to plant susceptibility. Plants with a high natural rate of IAA metabolism were less dependent on IAA and less susceptible to glyphosate. The practical implications of these findings are that glyphosate has a potential as plant growth regulator to be used in other areas of agriculture in addition to weed control; that IAA metabolism or ethylene production in plants may be used as an assay for screening new chemicals of this type; and that the natural rate of IAA metabolism may be used as an indicator for assessing plant tolerance for glyphosate.

Electroantennogram (EAG) studies of the European corn borer were continued. Considerable research has been conducted on the bioelectric activities of the receptor unit in a sensillum; however, very few of these studies involved investigation of the summation phenomenon (EAG) in relation to a single sensillum response. A new device for cutting and recording a single sensory hair by using two fine glass capillaries has been developed, which has made it possible to record EAG and ESG (electrosensillogram) responses simultaneously. The configuration characteristics of both responses resemble each other, and demonstrate an interaction between sensilla. The findings are important in understanding the underlying mechanisms of pheromone reception.

PUBLICATIONS

Research

Bowman, B. T.; Sans, W. W. 1983. Further water solubility determinations of insecticidal compounds. J. Environ. Sci. Health Part B 18:221-227.

Bowman, B. T.; Sans, W. W. 1983. Determination of octanol–water partitioning coefficients (K_w) of 61 organophosphorus and carbamate insecticides and their relationship to respective water solubility (S) values. J. Environ. Sci. Health Part B 18:667-683.

Campbell, J. M.; Tomlin, A. D. 1983. The first record of the palearctic species *Anotylus insecatus* (Gravenhorst) (Coleoptera: Staphylinidae) from North America. Coleopt. Bull. 37:309-313.

Carroll, K. A.; Harris, C. R.; Morrison, P. E. 1983. Resistance shown by a parathion-resistant onion maggot (Diptera: Anthomyiidae) strain to some other insecticides. Can. Entomol. 115:1519-1522.

Chapman, R. A. 1983. Chiral-phase high-performance liquid chromatographic separation of enantiomers of pyrethroid insecticide esters derived from α-cyano-3-phenoxybenyl alcohol. J. Chromatogr. 258:175-182.

Chapman, R. A.; Cole, C. M. 1982. Observations on the influence of water and soil pH on the persistence of insecticides. J. Environ. Sci. Health Part B 17:487-504.

Chefurka, W. 1983. The effect of DDT and related insecticides on the mitochondrial ATPase of houseflies. Comp. Biochem. Physiol. 74(C):259-266.

Cuppels, D. A. 1983. Isolation and characterization of phages useful for identifying *Pseudomonas syringae* pv. *tomato*. Phytopathology 73:1376-1381.

Deves, R.; Krupka, R. M. 1983. Apparent noncompetitive inhibition of choline transport in erythrocytes by inhibitors bound at the substrate site. J. Membr. Biol. 74:183-189.

Doux-Gayat, A.; Defago, G.; Kern, H.; Stoessl, A.; Stothers, J. B. 1983. The biosynthesis of phenanthrenoid phytoalexins. Incorporation of hexadeuteriophenylalanine into orchinol established by ^{2}H N.M.R. spectroscopy. J. Chem. Soc., Chem. Commun. 1983:157-159.

Harris, C. R.; Svec, H. J.; Tolman, J. H.; Chapman, R. A. 1983. Laboratory and field studies on the effectiveness and persistence of some insecticides used to control the tomato hornworm. Tob. Sci. 27:89-91.

Holenstein, J. E.; Kern, H.; Stoessl, A.; Stothers, J. B. 1983. The marticins: Evidence for a mixed origin from the polyketide and tricarboxylic acid pathways by [2-$^{13}C_1$] and [1,2-$^{13}C_2$]-acetate incorporation experiments. Tetrahedron Lett. 24(38):4059-4062.

Holenstein, J. E.; Stoessl, A. 1983. Metabolites of *Alternaria solani*, Part IX: Phytotoxicity of altersolanol A. Phytopathol. Z. 108:143-147.

Jennings, K. R.; Starratt, A. N.; Steele, R. W. 1983. The effect of insecticides containing the thionophosphoryl group on peptide neurotransmitter action in the hindgut of *Periplaneta americana*. Pestic. Biochem. Physiol. 19:122-132.

Jennings, K. R.; Steele, R. W.; Starratt, A. N. 1983. Cyclic AMP actions on proctolin- and neurally-induced contractions of the cockroach hindgut. Comp. Biochem. Physiol. 74(C):69-74.

Krupka, R. M. 1983. The kinetics of transport inhibition by noncompetitive inhibitors. J. Membr. Biol. 74:175-182.

Krupka, R. M.; Deves, R. 1983. Kinetics of inhibition of transport systems. Int. Rev. Cytol. 84:303-352.

Lee, T. T.; Dumas, T. 1983. Effect of glyphosate on ethylene production in tobacco callus. Plant Physiol. 72:855-857.

Lee, T. T.; Dumas, T.; Jevnikar, J. J. 1983. Comparison of the effects of glyphosate and related compounds on indole-3-acetic acid metabolism and ethylene production in tobacco callus. Pestic. Biochem. Physiol. 20:354-359.

MacDonald, R. S.; Surgeoner, G. A.; Solomon, K. R.; Harris, C. R. 1983. Effect of four spray regimes on the development of permethrin and dichlorvos resistance, in the laboratory, by the housefly. J. Econ. Entomol. 76:417-422.

MacDonald, R. S.; Surgeoner, G. A.; Solomon, K. R.; Harris, C. R. 1983. Development of resistance of permethrin and dichlorvos by the housefly (Diptera: Muscidae) following continuous and alternating insecticide use on four farms. Can. Entomol. 115:1555-1561.

Miles, J. R. W.; Harris, C. R.; Morrow, D. C. 1983. Assessment of hazards associated with pesticide container disposal and of rinsing procedures as a means of enabling disposal in sanitary landfills. J. Environ. Sci. Health Part B 18:303-315.

Miles, J. R. W.; Moy, P. 1982. Degradation of the insecticide fensulfothion by a mixed culture of soil microorganisms. J. Environ. Sci. Health Part B 17:675-681.

Nagai, T. 1983. Spread of local electroantennogram response of the European corn borer, *Ostrinia nubilalis*. Pestic. Biochem. Physiol. 19:291-298.

Nagai, T. 1983. On the relationship between the electroantennogram and simultaneously recorded single sensillum response of the European corn borer, *Ostrinia nubilalis*. Arch. Insect Biochem. Physiol. 1:85-91.

Robinson, J. R. 1983. Photodynamic insecticides: A review of studies on photosensitizing dyes as insect control agents, their practical application, hazards, and residues. Residue Rev. 88:69-100.

Stoessl, A. 1983. Secondary plant metabolites in preinfectional and postinfectional resistance. Pages 71-122 *in* The dynamics of host defence. Academic Press, Australia.

Stoessl, A.; Stothers, J. B. 1983. Tetrahydroaltersolanol B, a hexahydroanthranol from *Alternaria solani*. Can. J. Chem. 61:378-382.

Stoessl, A.; Stothers, J. B. 1983. Biosynthesis of antifungal stress metabolites from potato: Observation of hydride shifts via the "β-hop" from incorporation of [2-$^2H_3$,2-^{13}C] acetate and ^{13}Cmr. Can. J. Chem. 61:1766-1770.

Stoessl, A.; Unwin, C. H.; Stothers, J. B. 1983. On the biosynthesis of some polyketide metabolites in *Alternaria solani*: ^{13}C and ^{2}Hmr studies. Can. J. Chem. 61:372-377.

Tu, C. M. 1983. Effects of pyrethroid insecticide seed treatments on *Rhizobium japonicum* and its symbiotic relationship with, and growth of soybean. J. Environ. Sci. Health Part B 18:369-378.

Vardanis, A. 1983. Insect (cAMP-cGMP) - dependent protein kinase. *A chapter in* Hormone action: Protein kinases. Methods Enzymol. 99:71-76.

Ward, E. W. B. 1983. Effects of mixed or consecutive inoculation on the interaction of soybeans with races of *Phytophthora megasperma* f. sp. *glycinea*. Physiol. Plant Pathol. 23:281-294.

Ward, E. W. B.; Buzzell, R. I. 1983. Influence of light temperature and wounding on the expression of soybean genes for resistance to *Phytophthora megasperma* f. sp. *glycinea*. Physiol. Plant Pathol. 23:401-409.

White, G. A.; Thorn, G. D.; Ackrell, A. C.; Kearney, E. B.; Ramsay, R. R.; Singer, T. P. 1983. Site of action of carboxamides in mitochondrial complex II. *In* Miyamoto, J., et al., ed. IUPAC Pesticide Chemistry (Human Welfare and the Environment). Pure and Applied Chemistry. Pergamon Press.

Miscellaneous

Dumas, T. 1982. Book review. Robert L. Grob and Mary A. Kaiser, Environmental problems solving using gas and liquid chromatography, Elsevier Scientific Publ. Co., Amsterdam, 1982.

Miles, J. R. W. 1982. Book review. Pesticide disposal pollution technology review No. 81. Pestic. Biochem. Physiol. 17:205-206.

Robinson, J. R. 1983. Uses, hazards and safe-handling of ionizing radiation in agricultural applications. *In* Parmeggiani, L., ed. Encyclopaedia of occupational health and safety, Vol 2. 3rd ed. International Labour Office, Geneva.

Starratt, A. N. 1983. Book review. F. Lottspeich, A. Henschen, and K.-P. Hupe, eds., High performance liquid chromatography in protein and peptide chemistry, de Gruyter, Berlin/New York, 1981. Pestic. Biochem. Physiol. 19:114.

Tomlin, A. D. 1982. Book review. Norman Hudson, Soil conservation, 2nd ed., Cornell University Press, 1981. Can. Field-Nat. 96:508.

Tomlin, A. D. 1983. Book review. R. L. Metcalf and W. H. Luckman, eds., Introduction to insect pest management, 2nd ed., Wiley-Interscience, New York, 1982. Pestic. Biochem. Physiol. 20:1036.

Research Station
Delhi, Ontario

PROFESSIONAL STAFF

P. W. Johnson, B.S.A., M.Sc., Ph.D.	Director
E. G. Ashby	Administrative Officer
M. Skrypuch, B.A.(Eng.), M.L.S.	Librarian

Tobacco

H. H. Cheng, B.Sc., M.Sc., Ph.D.	Entomology
W. A. Court, B.Sc., M.Sc., Ph.D.	Chemistry
J. M. Elliot, B.S.A., M.S.A.	Soil science
S. K. Gayed, B.Sc., M.Sc., Ph.D.	Plant pathology
R. S. Pandeya, B.Sc., M.Sc., Ph.D.	Genetics and plant breeding
N. Rosa, B.Sc., M.Sc., Ph.D.	Plant physiology
E. K. Walker, B.S.A., M.S.	Plant science
B. F. Zilkey, B.S.A., M.Sc., Ph.D.	Plant physiology

New Crops

R. C. Roy, B.Sc. (Agr.), M.Sc.	Agronomy

DELHI ENGINEERING RESEARCH GROUP[1]

D. A. Stier, B.Sc.	Engineer

EXTENSION SERVICES[2]

N. W. Sheidow, B.Sc.	Tobacco
M. C. Watson, B.S.A.	Tobacco

AGRICULTURAL ENERGY CENTRE[2]

M. J. COLUMBUS, B.Sc. (Agr.)	Energy Specialist

VISITING SCIENTIST

A. WALTHER, B.Com., B.Sc., M.Sc., Ph.D. Department of Biology, University of Regina, Regina, Saskatchewan	Plant ecology and physiology

---

[1] Provided by the Ontario Flue-Cured Tobacco Growers' Marketing Board and the Canadian Tobacco Manufacturers' Council.

[2] Provided by Ontario Ministry of Agriculture and Food.

INTRODUCTION

The Delhi Research Station conducts a multidisciplinary research program in support of the flue-cured tobacco industry in Ontario, Quebec, and the Maritimes to provide the technology required by growers to produce the high-quality tobacco required by both domestic and export customers.

Basic research in genetics, chemistry, biochemistry, and physiology is conducted in support of goal-oriented research to increase production efficiency, chemical and physical quality, and usability of tobacco through improved production practices, varieties, protection measures, and harvesting and curing technology. Engineering research on energy utilization and mechanization is conducted by the Delhi Engineering Research Group (DERG), which is jointly funded by the Ontario Flue-Cured Tobacco Growers' Marketing Board and the Canadian Tobacco Manufacturers' Council. A new-crops program is currently working on alternative or rotational crops for the sandy soils of the tobacco area.

Reprints of research publications and copies of this report are available from the Research Station, Research Branch, Agriculture Canada, P.O. Box 186, Delhi, Ont. N4B 2W9.

P. W. Johnson
Director

TOBACCO PRODUCTION

Germination

Tobacco seeds, germinated in water, approach maximum imbibition during the initial 4 to 6 h, then enter a quiescent stage until 52 to 56 h, when open ends of the seed appear just prior to radicle protrusion.

Inhibition or delay of germination was not related to adverse temperatures (up to 50°C), intermittent desiccation, or anaerobiosis during the imbibition or quiescent stage. Salt leakage from the seed, in excess of 1000 μmhos/cm, may be partially responsible for germination inhibition.

Seedling culture

Plants grown in media containing a mixture of muck and peat-based media (4:1 or 6:1) had greater shoot weight, shorter stems, thicker stems, and fewer days to flowering than plants grown in muck top-dressed with vermiculite. Imposition of forking resulted in reduction of stem length, ratio of stem length to diameter, shoot weight, and ratio of shoot-to-root weight. Forking increased root weight only in a standard muck bed.

Mechanically clipped seedbed plants were intermediate between forked and nonhardened plants in pulling force, but similar to forked plants in length of stem and ratio of stem length to diameter. Clipped plants had more slender stems than forked or nonhardened plants, and less shoot and root growth. Shoot-to-root ratios of clipped plants were similar to those of nonhardened plants, whereas days to flowering fell between those of forked and nonhardened plants.

Soil fertility and fertilization

Fumigant nematicides, particularly those containing chloropicrin, slowed the rate of nitrification more than contact nematicides, during the first 6 wk after transplanting tobacco. Comparison of 100% urea-N, 100% NH_4^+-N, 75% NH_4^+-N plus 25% NO_3^--N, and 50% NH_4^+-N plus 50% NO_3^--N as forms of fertilizer nitrogen showed that rate of transformation of soil NH_4^+-N to soil NO_3^--N was affected only by type of nematicide, not by the form of fertilizer nitrogen. In years with heavy rainfall in June or early July, fumigants conserve soil nitrogen as NH_4^+-N which is not readily leached.

Sidedressed 3-6-18 fertilizer, applied to repeat cropland at rates increased by increments of 100 kg/ha, increased yield by 13% with the first increment and a further 7% with the second increment in a year with a high June rainfall; yield increases of only 6% and 3%, with the same increments, were obtained in a year with normal rainfall in June.

Growth analysis

During 1983, tobacco showed an unusual arrest of growth during late June and early July. This resulted in delayed maturity in spite of an otherwise excellent season.

Cultivars differed in their response. For 27–30 June, *Nicotiana tabacum* L. selection M-26 exhibited the greatest growth suppression, followed by Delhi 76, Candel, and Pale Yellow. For 5–7 July, growth suppression was greatest for Pale Yellow, with lesser suppression of Delhi 76, M-26, and least for Candel.

Ripening agents

Ethephon treatment lowered the agronomic indices and produced leaves with a darker base color and less green (or more red) hues than a control treatment. Ethephon use also resulted in a reduction of green grades, and increases of gray, orange, and mahogany grades. Undesirable gray was minimal, however, with ethephon at the rate of 50 mg per plant. An increase in desirable dark grades (orange and mahogany) was offset, with ethephon at the rate of 100 mg per plant, by an increase in gray grades.

Curing

Introductions of ethylene gas, at levels of 25–100 ppm, during the yellowing phase of curing reduced curing time and amounts of green tissue, and darkened the base color of leaves. This had a positive effect on salability but a negative influence on smoking quality.

GENETICS AND PLANT BREEDING

Inheritance of phenolics

Genetic analyses of phenolics in flue-cured tobacco (*N. tabacum* L.) were conducted on a five-parent diallel set. The general combining ability (GCA) and specific combining ability (SCA) indicated genetic controls for all phenolics. Additive genetic variance was the predominant contributor in the expression of chlorogenic acid and its isomers, and scopoletin, scopolin, and rutin; dominance, if present at certain loci, was in the partial dominance range. Nonallelic interactions were negligible for all phenolics, except scopoletin and rutin. Chlorogenic acid and its isomers were under dominant gene controls, while scopoletin, scopolin, and rutin were under recessive gene control. Positive pleiotropic effects were exhibited by all phenolic constituents except scopoletin, where negative correlations were prevalent. This suggests that selection, if exercised on chlorogenic acid, would result in a predictable correlated response in other related traits.

New flue-cured tobacco licensed

An early-maturing, good-quality flue-cured tobacco cultivar, Candel, was licensed on 1 December 1983 by the Plant Health and Quarantine Directorate of Food Production and Inspection Branch, Agriculture Canada, under license no. 2349. Candel was derived from an *N. tabacum* – *N. rustica* interspecific hybridization program.

CHEMISTRY

Neoxanthin, biolaxanthin, lutein, β-carotene, chlorophyll a, and chlorophyll b levels in flue-cured tobacco (*N. tabacum* L.) were determined at intervals from the middle of July through harvest. Harvested leaves were also sampled during curing for pigment determinations. Except where interrupted by rainfall or irrigation, pigment concentrations progressively declined during plant growth; the decline was accelerated during curing. Carotenoid degradation during curing was proportional to its degree of oxygen substitution. Chlorophyll a and chlorophyll b levels in cured tissue were typically less than 1% of that present at harvest.

Certain cigarette smoke characteristics were measured in flue-cured tobacco grown on 31 farms in 1980 and 29 farms in 1981. Smoke TPM, tar, and tar-to-nicotine ratio were reduced and the nicotine level was maintained in 1981 compared with 1980. Total aldehyde and neophytadiene levels tended to increase slightly in 1981 compared with 1980. The increased use of Delgold as the main production variety best explains the changes in smoke component levels.

TOBACCO PROTECTION

Entomology

Population monitoring. Density levels of eight lepidopterous species of tobacco pests were recorded from blacklight traps in the tobacco district of Ontario for the 16th yr. Moths collected in 1983 indicated that the spotted cutworm and variegated cutworm were most abundant; densities of the dark-sided cutworm, striped cutworm, and black cutworm were moderate; and those of the dingy cutworm, sandhill cutworm, and tomato hornworm were low.

Chemical control. Evaluation of six pyrethroids, cyfluthrin, cypermethrin, deltamethrin, fenvalerate, flucythrinate, and permethrin, and two organophosphorus insecticides, acephate and chlorpyrifos, applied against the darksided cutworm on the soil surface showed that all pyrethroids were similar in effectiveness and residual toxicity. On air-dry soil surfaces in the greenhouse, pyrethroids were significantly more toxic and persistent than was chlorpyrifos. On moderately moist soil surfaces in the field, chlorpyrifos was as toxic to the cutworm larvae as the pyrethroids, but less persistent. Pyrethroids were not affected by soil moisture to the same extent as chlorpyrifos. Acephate-treated soil surfaces, regardless of conditions, were less toxic and the toxicity was less persistent than for chlorpyrifos-treated soil.

Insecticide residues. Residues of chlorpyrifos, cypermethrin, oxydemeton-methyl, permethrin, and pirimicarb were not detected in any cured leaf samples. Residues of acephate ranged from nondetectable to present at very low levels, averaging 0.22 ppm.

Plant pathology

Blue mold. Blue mold was recorded on 8 August near Silverhill in three fields that had not been treated with metalaxyl. Contract research proved that oospores of *Peronospora tabacina* Adam. that overwintered after the 1979 blue mold epiphytotic were scarce and apparently nonviable.

Metalaxyl in the planting water at a.i. rates of 200–400 g/ha caused initial stunting of young tobacco plants, but later their yield and quality were comparable to those of the untreated control. The experimental systemic fungicide SAN 371F (Sandoz) had no undesirable effect on tobacco yield or quality and laboratory studies demonstrated its efficacy in protecting tobacco plants against blue mold.

Pole rot. Ethephon at 2.8 L/ha, sprayed on tobacco plants after the second priming, reduced yellowing time in curing the third and fourth primings by 20%, thus reducing the time that tobacco in the kiln is susceptible to pole rot.

Black root rot. Steaming or methyl bromide treatment at 50 g/m^2 of the tobacco seedbed was more effective in controlling *Thielaviopsis basicola* than metam sodium at 42 mL/m^2 or dazomet at 60 g/m^2.

Weed control

Ethylan TT-15, a cationic surfactant, at 0.5% (v/v) enhanced postemergence control of quack grass by glyphosate or the experimental herbicide SC-0224. Quack grass control with these treatments is most effective, on a spot basis in the alternate crop, in late April or mid-September when it is actively growing at the fourth to fifth leaf stage.

NEW CROPS

Peanut crop area remained static at 220 ha. Factors responsible for this no-growth phase include a cool, poor growing season in 1982; poor performance of harvesting equipment; and a general downturn in the economy.

Five successive harvest dates of peanut (*Arachis hypogaea* L.) cultivars Comet (Spanish type) and McRan (Valencia type) were evaluated for their influence on agronomic and chemical characteristics. Delayed harvesting enhanced yield, sound mature kernels, seed-to-hull ratio, oil content, and economic returns. Differences between cultivars, rather than harvest date, contributed most of the variability in oil and fatty acid levels. Immature peanuts produced higher crude protein, higher palmitic, behenic, and lignoceric acid levels, and lower oleic acid levels.

Two postemergence herbicides, sethoxydim and fluazifop-butyl, controlled escaped annual grasses in peanut plantings.

The 1983 peanut crop produced average yields, although isolated fertility problems and drought reduced yields in some fields.

Preliminary yield evaluation was conducted on flour chick-peas, fenugreek, adzuki beans, safflower, and winter canola. Further testing is required for yield and economic stability.

PUBLICATIONS

Research

Court, W. A.; Binns, M. R.; Hendel, J. G. 1983. Examination of the influence of curing and stalk position on the phenolic constituents of flue-cured tobacco. Tob. Sci. 27:51-55.

Court, W. A.; Hendel, J. G. 1983. Chemical composition of flue-cured tobacco cultivars with different sensitivities to weather fleck. Can. J. Plant Sci. 63:293-297.

Elliot, J. M. 1983. Nutrition. Pages 17-38 (1974) *in* Recent Adv. Tob. Sci. (inaugural vol.).

Elliot, J. M., ed. 1983. Production of quality leaf tobacco. Recent Adv. Tob. Sci. 229 pp.

Gayed, S. K. 1983. The effect of ethylene diurea on weather fleck and on certain properties of the flue-cured tobacco in Ontario. Tob. Sci. 27:149-150.

Pandeya, R. S.; Dirks, V. A.; Poushinsky, G. 1983. Quantitative genetic studies in flue-cured tobacco *Nicotiana tabacum* L. I. Agronomic characteristics. Can. J. Genet. Cytol. 25:336-345.

Siddiqui, I. R.; Rosa, N. 1983. Low molecular weight carbohydrates of tobacco. Tob. Sci. 27:130-134.

Walker, E. K.; Reynolds, L. B. 1983. Culture of flue-cured tobacco seedlings: Influences of media and forking in seedbeds. Tob. Sci. 27:77-81.

Miscellaneous

Binns, M. R.; Basrur, P. K.; Zilkey, B. F.; Court, W. A.; Pandeya, R. S.; White, F. H. 1983. Comparative mutagenic assay of cigarette smoke condensates: An evaluation based on Canadian experimental cigarettes. Agric. Can. Tech. Bull. 1-518. 39 pp.

Cheng, H. H. 1982. Seasonal occurrences of insect pests on tobacco and peanuts in Ontario. Can. Agric. Insect Pest Rev. 60:24-25,47.

Cheng, H. H. 1983. History of insect control on tobacco in Canada. The Lighter 53(3):28-32.

Court, W. A. 1983. Fifty years of chemical research at Delhi. The Lighter 53(3):11-12.

Court, W. A. 1983. Physiology, chemistry and tobacco smoke. The Lighter 53(4):12-17.

Elliot, J. M. 1983. Fertilization. The Lighter 53(1):22-26.

Elliot, J. M. 1983. History of flue-cured tobacco fertilization research at Delhi. The Lighter 53(3):13-15.

Elliot, J. M. 1983. History of nematicide research at Delhi. The Lighter 53(3):16-17.

Elliot, J. M.; Beyaert, R. P.; Pocs, R. 1983. A survey of flue-cured tobacco grown in Ontario in 1981. Part II: Soil characteristics and nutrient elements. The Lighter 53(4):18-21.

Elliot, J. M.; Pocs, R.; Beyaert, R. P. 1983. A survey of flue-cured tobacco grown in Ontario in 1982. Levels of some chemical constituents and lamina weight. The Lighter 53(2):28-30.

Gayed, S. K. 1983. Blue mold incidence, spread and severity in United States and Canada, 1981. The Lighter 53(1):27-30.

Gayed, S. K. 1983. History of research on tobacco diseases, 1933–1983. The Lighter 53(3):18-19.

Gayed, S. K. 1983. Blue mold of tobacco. Agdex 181/632.

Pandeya, R. S. 1983. Historical accounts of flue-cured tobacco genetics and breeding. The Lighter 53(3):22-25.

Pandeya, R. S.; Ankersmit, J. C. D.; Rogers, W. D. 1982. Newdel, a new flue-cured cultivar released for 1982. The Lighter 52(4):26-29.

Rosa, N. 1983. Cultural practices. The Lighter 53(1):16-21.

Rosa, N. 1983. Development of chemicals for control of axillary bud (sucker) growth of tobacco. The Lighter 53(3):33-35.

Roy, R. C. 1983. History of alternate and rotational crop research at Delhi. The Lighter 53(3):26-27.

Stier, D. A.; Walker, E. K. 1983. Engineering studies on flue-cured tobacco, 1982–1983. Rep. No. 6, Delhi Eng. Res. Group and Delhi Res. Stn.

Walker, E. K. 1982. Tobacco work planning meeting: Seedling production. The Lighter 52(4):22-25.

Walker, E. K. 1983. Mechanical and technological developments for flue-cured tobacco production in Ontario. The Lighter 53(3):35-39.

Walker, E. K. 1983. Delhi Research Station, 1933–1983. Hist. Ser. No. 17. Agric. Can., Res. Branch. 31 pp.

White, F. H.; Pandeya, R. S.; Arsenault, W. 1982. Islangold: Superior disease tolerant flue-cured tobacco with high yield and quality under Maritime conditions. The Lighter 52(4):15-17.

White, F. H.; Pandeya, R. S.; Arsenault, W. 1983. Windel: A high yielding, wind tolerant flue-cured tobacco for Maritimes. The Lighter 53(1):31-33.

Zilkey, B. F. 1983. Plant protection. The Lighter 53(2):17-24.

Zilkey, B. F. 1983. History of tobacco weed control at Delhi, 1933–1983. The Lighter 53(3):20-21.

Zilkey, B. F.; Capell, B. B. 1983. Cigarette smoke analysis from a farm survey of flue-cured tobacco in Ontario in 1981. The Lighter 53(2):25-27.

Zilkey, B. F.; Capell, B. B. 1983. The effect of herbicides on agronomic and chemical characteristics of flue-cured tobacco in Ontario in 1981. The Lighter 53(4):22-25.

Research Station
Harrow, Ontario

PROFESSIONAL STAFF

C. F. Marks, B.Sc. (Agr.), M.S.A., Ph.D.	Director
P. B. Marriage, B.Sc., Ph.D.	Assistant Director
L. P. Ryan[1]	Administrative Officer
E. Champagne,[2] M.A., M.L.S.	Librarian

Crop Science

R. I. Buzzell, B.Sc., Ph.D.	Head of Section; Soybean breeding
B. R. Buttery, B.Sc., Ph.D.	Soybean physiology
V. A. Dirks, B.S.A., M.Sc., Ph.D.	Statistics
S. J. Park, B.S.A., M.S., Ph.D.	Field bean breeding
A. H. Teich, B.A., B.S.A., M.Sc., Ph.D.	Winter wheat breeding
T. W. Welacky, B.Sc., B.Sc. (Agr.)	Burley tobacco

Entomology

W. H. Foott, B.S.A., M.S.A., Ph.D.	Head of Section; Field crop insects
R. P. Jaques, B.S.A., M.S.A., Ph.D.	Insect pathology
G. J. R. Judd,[3] B.S.A., M.P.M.	Vegetable entomology
R. J. McClanahan, B.A., M.Sc., Ph.D.	Greenhouse and field vegetable insects
B. C. Smith, B.A.	Field crop insects

Horticultural and Soil Science

W. I. Findlay, B.Sc., M.Sc., Ph.D.	Head of Section; Soil fertility
R. W. Garton, B.Sc. (Agr.)	Vegetable cultivar evaluation and management
T. J. Jewett, B.Sc.	Greenhouse energy engineering
F. Kappel,[4] B.Sc. (Agr.), M.Sc.	Orchard management
R. E. C. Layne, B.Sc., M.S., Ph.D.	Tree fruit breeding
A. Liptay, B.S.A., M.Sc., Ph.D.	Vegetable management

A. P. Papadopoulos,[5] M.Sc. (Agr.), M.Sc. (Hort.)	Greenhouse management
J. A. Stone, B.S., M.S., Ph.D.	Soil physics
C. S. Tan, B.Sc., M.Sc., Ph.D.	Soil moisture and agrometeorology

Plant Pathology

W. R. Jarvis, B.Sc., Ph.D., D.I.C.	Head of Section; Vegetable diseases
T. R. Anderson, B.S.A., M.Sc., Ph.D.	Soybean diseases
W. G. Bonn, B.Sc., M.S., Ph.D.	Bacterial diseases of fruit and vegetables
B. N. Dhanvantari, B.Sc., M.Sc., Ph.D.	Bacterial diseases of vegetables
L. F. Gates, B.A., Ph.D.	Cereal and corn diseases
J. A. Traquair, B.Sc., Ph.D.	Tree fruit diseases
J. C. Tu, B.Sc., M.Sc., Ph.D.	White bean diseases

Weed Science and Chemistry

A. S. Hamill, B.Sc., M.Sc., Ph.D.	Head of Section; Weed science
J. D. Gaynor, B.Sc., M.Sc., Ph.D.	Environmental chemistry
P. B. Marriage, B.Sc., Ph.D.	Weed physiology
D. R. Phillips,[6] B.Sc., M.Sc., Ph.D.	Weed physiology
S. E. Weaver, B.A., Ph.D.	Weed ecology

Departure

W. M. Elliott, B.Sc., Ph.D., D.I.C. Retired July 1983	Vegetable and fruit insects

EXTENSION SERVICES[7]

J. C. Fisher, B.S.A.	Greenhouse and fresh market vegetables
L. A. Huffman, B.Sc. (Agr.)	Fruit crops and asparagus

---

[1] Joined staff 14 February 1983.

[2] Seconded from Libraries Division, Finance and Administration Branch.

[3] Joined staff 28 September 1983; on educational leave, Simon Fraser University, B.C., September 1983–.

[4] On educational leave, University of Guelph, September 1982–.

[5] On educational leave, University of Guelph, September 1982–.

[6] Seconded to CIDA Barani (Rainfed) Agricultural Research and Development Project, Pakistan, 1 May 1983–.

[7] Provided by Ontario Ministry of Agriculture and Food.

INTRODUCTION

The Research Station at Harrow serves southwestern Ontario, where favorable soils and climatic conditions permit an intensive and diversified agriculture. The Station has 31 scientists involved in interdisciplinary research in eight commodity-oriented programs designed to improve yield, quality, and efficiency of crop production. Crops under study include field and greenhouse vegetables, stone fruits, pome fruits, corn, soybeans, field beans, winter wheat, and burley tobacco. Crop improvements are achieved by the breeding of new varieties with superior characteristics and the development of improved crop, pest, and soil management practices.

Significant changes during 1983 are the addition of Mr. L. P. Ryan, Administrative Officer, and Mr. G. J. R. Judd, vegetable entomology; and the retirement of Dr. W. M. Elliott, vegetable and fruit insects.

The report provides brief summaries of results obtained in 1983. Further information can be obtained by writing to the Research Station, Research Branch, Agriculture Canada, Harrow, Ont. N0R 1G0.

C. F. Marks
Director

FIELD CROPS

Corn

Breeding. Three yellow dent inbreds, CH711-10, CH732-12, and CH741-6, were released. All three lines are characterized by high yield in test crosses, good stalk quality, and resistance to leaf feeding by the first brood of the European corn borer. Initial acceptance by the seed corn industry has been good for CH732-12 and CH741-6.

Corn rootworms. Using techniques for monitoring adults with sticky traps and pheromone traps, methods were developed to quantify parameters involved in relationships between rootworm infestations and yield losses. The level of economic injury to grain corn that justifies the use of control measures occurs with an average trap catch of 700 adults of the western corn rootworm per square metre per day. Application of soil insecticides when the corn crop was planted did not prevent larvae from surviving to the adult stage. It was shown in a survey that 41% of nontreated fields and 29% of treated fields had populations of adult western corn rootworms that exceeded the economic threshold. The large numbers of adults caught on sticky traps incorporating the female sex pheromone of this rootworm, that is, 4400–8894/m^2 per day, suggest that pheromone traps can be used to reduce local populations.

Crop management effects on the surface structure of poorly drained soil. Annual measurements of bulk density, total porosity, and air-filled porosity taken from the 0.05–0.15 m depth of a Brookston clay loam soil, inclusively from 1957 to 1982, were evaluated. Additional measurements of bulk density, porosity, stability, and resistance to penetration were made on samples taken from the 0.05–0.15 m and 0.15–0.25 m depths in 1983. The treatments were: (*a*) continuous corn with no fertilizer; (*b*) continuous corn with ammonium nitrate at 298 kg/ha annually; (*c*) continuous corn as in (*b*) plus 5-20-20 fertilizer at 675 kg/ha annually; and (*d*) a corn–oats–alfalfa rotation receiving 5-20-20 at 168 kg/ha for oats. In general, bulk density increased as total and air-filled porosities decreased with time for all treatments. However, lower bulk densities and higher total porosities were found under rotation-corn than under continuous-corn treatments. Where continuous corn was grown, no differences in bulk density or porosity were found among the fertilizer treatments. The soil stability and penetration measurements did not show any meaningful treatment effects. Monoculture corn appeared to have played a minor role in the structural deterioration of this poorly drained, weakly structured soil.

Triazine-resistant weeds. In 1982, a survey was conducted to discover the locations and overall distribution of lamb's-quarters and pigweed resistant to atrazine and other triazine-based herbicides in Kent County, where one field of resistant lamb's-quarters was observed in 1981. Triazine-resistant lamb's-quarters was found in seven locations close to each other in Howard Township and at two distinct outlying sites. This represented 13% of the fields surveyed. In 1983, only limited spread of the weed from these locations was reported by the growers concerned. No fields were found to contain pigweeds resistant to triazine herbicides.

Weed competition. The effects of soil pH (4.8, 6.0, or 7.3) on the growth, competitive ability, and leaf nutrient content of corn and green pigweed, velvetleaf, and green foxtail were measured. Corn yields were significantly reduced by weed competition at all pH levels, but leaf nutrient content, as a percentage of dry weight, was not affected. The aboveground dry weight and competitive ability of green pigweed and velvetleaf were significantly reduced at pH 4.8 but not at pH 6.8 or 7.3, whereas growth and competitive ability of green foxtail were greater at pH 4.8 than at pH 7.3. Velvetleaf and green pigweed showed increased levels of S, Al, Zn, and especially Mn, when grown at pH 4.8. Levels of N and K in the leaf tissue were much greater in the weed species than in corn at all soil pHs. The broad-leaved species had higher levels of Ca and Mg in the leaf tissue at all soil pH levels and accumulated higher levels of Mn at low pH than the grasses. The ability of weeds to accumulate high levels of particular nutrients, and the influence of soil pH on leaf micronutrient concentrations, may have an important bearing on the quality of silage or hay contaminated with weed tissue. The slight but significant changes in competitive ability of weeds with changes in soil pH suggest that decreasing soil pH in agricultural fields may result in gradual long-term shifts in the weed flora.

Weed control. Over a 4-yr period, cultivation plus use of the recommended rate of alachlor + atrazine + dicamba applied before emergence maximized corn yields, even though the broad-leaved weed control was only 84%. Using the herbicide by itself allowed a yield of 83% of the potential while control of broad-leaved weeds dropped to 46%. Cultivation permitted banding of the herbicide or application of three-quarters of the recommended rate with yield reductions of 2% and 6%, respectively. Without the cultivation, yield reductions were over 25% of the potential and control of broad-leaved weeds dropped to 35% or less. Grass weeds were not a problem and velvetleaf was the major broad-leaved weed escape.

Soybeans

Disease. Thielaviopsis root rot of soybean was determined to be endemic within Essex and Kent counties. Currently recommended cultivars are tolerant of the disease.

Herbicide residues. The herbicide diclofop-methyl is registered for control of annual grasses in soybeans. The persistence of this herbicide in Brookston clay and Fox sandy loam soil was found to be short, with less than 14% of the applied herbicide remaining at the end of the growing season. Low soil pH reduced the rate of hydrolysis of the herbicide ester, but pH had no effect on subsequent degradation of the acid or on formation and accumulation of breakdown products. The rate of breakdown of the herbicide was similar on clay and sandy loam soils. Combustion of sandy loam soil treated with radioactive diclofop-methyl revealed that 30% of the radioactivity that was not recovered by solvent extraction remained in the soil at the end of the growing season. The chemical composition of the nonextractable radioactivity has not been determined.

The persistence of three dinitroaniline herbicides in clay soil and two in sandy loam was determined for 2 yr. Dinitramine at 0.55 kg/ha and ethalfluralin at 1.0 kg/ha dissipated to less than 20% of that applied to clay soil within 70 days whereas trifluralin at 1.0 kg/ha was more persistent, with 40% remaining after 110 days. Trifluralin and oryzalin applied at 2.0 kg/ha to a sandy loam soil showed similar persistence, with 30% residue remaining after 80 days. Ethalfluralin and dinitramine residues would not be expected to carry over at phytotoxic concentrations to the next growing season but trifluralin and oryzalin residues could be phytotoxic to susceptible crops in the subsequent year.

Nitrogen fixation. Ten soybean cultivars cultured for 31–41 days in the presence and absence of nitrate differed in their interactions with 12 strains of *Rhizobium japonicum* in the formation of nodule dry weight. Cultivars and strains both interacted with nitrate level; some cultivars and some strains produced relatively more plant and nodule weight in the presence of nitrate. It should be possible to select cultivars and strains that would have improved nodulation in the presence of nitrate, which occurs at an appreciable level in most agricultural soils.

Photosynthesis and bean yield. Photosynthetic rate (PA) measured three times during pod-fill on 62 soybean lines, each obtained from a different cross without yield testing, was significantly correlated ($r = 0.34$; $P = 0.01$) with bean yield unadjusted for maturity. The low correlation between PA and yield limits the use of PA as a separate selection criterion. Lines with high PA and with intermediate PA had equally high yield, which indicates that some other factor such as leaf area may be important.

Response of velvetleaf to metribuzin. Velvetleaf, a serious problem in soybeans and other crops, has a wide distribution across Ontario and Quebec, and beyond. Fifteen populations, representing those in Ontario from the southwest to the northeast, and ones from Quebec, Ohio, and Michigan, were examined for their susceptibility to metribuzin, a herbicide commonly used to control this weed in soybeans. No major differences were observed among populations in their response to metribuzin, as measured by growth in nutrient culture in the presence of the herbicide at 1×10^{-6} M and by increase in leaf fluorescence after exposure of leaf disks to metribuzin in solution at various concentrations. Recommendations for velvetleaf control involving metribuzin therefore apparently do not have to take into account any differences in population susceptibility or tolerance.

Burley tobacco

Diseases. A new disease of air-cured burley tobacco was identified at several locations in 1982–1983. It is caused by *Botryosporium longibrachiatum*. Incidence of the mold can be reduced by supplementary heat during the curing process.

Field beans

Alternaria black pod. Alternaria alternata was identified as the cause of black pod disease and grayish discoloration of the seed coat of white beans. The disease was more severe in the early-maturing cultivar Seafarer than in the late-maturing cultivar Ex Rico 23. The fungus is insensitive to benomyl but is sensitive to iprodione.

Anthracnose. Race epsilon of bean anthracnose (*Colletotrichum lindemuthianum*) was isolated near Kerwood, Ont. Although the race is new to Canada, new cultivars (Harofleet, Harokent, OAC Seaforth, and OAC Rico) that were released recently are resistant to the race because they carry the resistant *Are* gene which gives resistance to races alpha, beta, gamma, delta, epsilon, and lambda.

Bacterial blight. In field evaluations at Harrow, 1983 breeder seed of cultivars Fleetwood and Kentwood, planted in four blocks of 14 rows each per cultivar and producing in excess of 10 000 plants per cultivar, showed few primary infection foci. Most of the yellow foliar lesions seen later in the season were associated with *Alternaria* sp.

Artificially infiltrated seeds (cultivar Fleetwood) were used in seed disinfection studies. In a constant-temperature water bath, the minimum temperature required for complete disinfection was 55°C for 20 min, but germination was reduced to only 6%. Among the antibiotics tylosin tartrate, tetracycline-HCl, and streptromycin sulfate tested in methanol, streptomycin and tetracycline achieved better disinfection at 1000 μg/mL, although all antibiotic treatments resulted in very poor plant stand.

Artificial infiltration of bean seeds (cultivar Fleetwood) with blight bacteria under partial vacuum for 20 min resulted in reduced germination and poor plant stand, both in the greenhouse and in the field. Symptoms of primary infection in such seeds and plants growing from them included reduced germination and wilt or blight, or both, of the primary leaf. In the field tests where 0–100% infiltrated seeds were planted (at intervals of 10%), plant stand decreased with increasing percentage of infiltrated seeds, for example, 50 and 100% infiltrated seeds produced plant stands of 80 and 10%, respectively, against a background of a 93% plant stand from uninfiltrated seeds.

Breeding. Four new white bean cultivars, Harokent, Harofleet, OAC Seaforth, and OAC Rico, were released and licensed jointly with the University of Guelph. These cultivars were derived by backcrossing anthracnose resistance into Kentwood, Fleetwood, Seafarer, and Ex Rico 23, respectively. Breeder seed of Harokent and Harofleet will be maintained by the Harrow Research Station.

In tests for screening germ plasm, three white beans, PVH 32, MO 3, and line

1455005, were identified as having tolerance for seed discoloration caused by delayed harvest. *Phaseolus vulgaris* entries BAC 13, BAC 112, and CIAT 2 were moderately tolerant of common bacterial blight (*Xanthomonas phaseoli*) and had desirable plant type. Most scarlet runner beans (*P. coccineus*) were highly tolerant and all tepary beans (*P. acutifolius*) were immune to the common blight. Five cranberry beans, one black bean, and one white bean were shown to be tolerant of the herbicide metobromuron.

Data from Ontario field bean variety trials for five cultivars grown during 1977–1982 were analyzed to determine yield stability and the suitability of seven test sites in southwestern Ontario. Seafarer had the highest stability for bean yield and Steuben was the least stable. There were no significant genotype × year interactions but significant genotype × location interactions indicated the importance of selecting representative test sites.

Viruses. Resistance to a necrotic strain of bean yellow mosaic virus (BYMV-N) and to a severe bean strain of tobacco ringspot virus (TRSV-S) in *P. vulgaris* cultivar Kentwood was found to be conditioned by independent single recessive genes, both derived from Clipper, a parent of Kentwood.

Winter wheat

Breeding. H 1-11-3, a selection out of the cross Fredrick × Yorkstar, was the highest yielding 2nd-yr entry in southwestern Ontario in the cooperative trials. It appears to be especially well adapted to areas 1 and 2, where about 85% of the Ontario crop is grown. It is short, early maturing, resistant to lodging and powdery mildew, and intermediate between Fredrick and Yorkstar in milling and baking quality.

Fusarium head blight. A survey of 22 farms in Lambton County in 1983 indicated that the overall frequency of *Fusarium* head blight was low. It was seven times greater, however, on farms where the previous crop was corn rather than soybeans or another small grain, and was twice as large where N and P fertilization was below recommended levels.

Insects. A study to examine the biology of the bluegrass billbug, *Sphenophorus parvulus* Gyllenhal, in nature and in the laboratory, and to estimate its economic importance as a pest of winter wheat, was completed.

The bluegrass billbug was found to cause some damage to winter wheat, particularly within several metres of the field periphery and especially in the presence of quack grass. Quack grass control is therefore a means of reducing potential damage by this insect. Movement from hibernating sites such as weedy sod into fields commenced in early May. Eggs were found in wheat stems by mid-May, larvae by 21 May, pupae by late July, and teneral adults by 1 August. Larvae were found as late as mid-September, indicating the possibility of a partial second generation. However, from other data obtained, it is probable that there is a long-lasting single generation.

In the laboratory, the mean periods for development of eggs, larvae, and pupae at a temperature of 24 ± 1°C and with a light/dark cycle of 16/8 h were 7.72, 27.20, and 8.88 days, respectively. The most notable aspect of these studies was the low fecundity of the females. The maximum number of eggs laid per female was 94 and the mean number for 40 females was only 38.32.

An investigation of the billbug's economic importance in winter wheat showed that moderate infestations often existed at the border of fields, but there was usually a large decrease in infestations short distances away from the periphery. This occurred because adults overwintered in weedy sod at the edge of fields and because quack grass, an important host of the beetle, was more common at the border. If quack grass existed throughout a field, then billbug infestations were also prevalent away from field margins.

It was concluded that because of the relatively low populations of billbugs in most fields, and the fact that most growers rotate their crops, this insect is not very destructive to winter wheat at present. Failure to control quack grass and to rotate could result in light to moderate losses.

HORTICULTURAL CROPS

Field vegetables

Cucumbers

Breeding. The new cultivar Harrow Jubilee was released from the Harrow pickling cucumber breeding program in the fall of 1983. It is the F_1 hybrid of a gynoecious seed parent and a monoecious pollen parent. Its main features are good productivity, shape, and color, and excellent fresh and salt-stock quality. It is highly tolerant of angular leaf spot and cucumber mosaic virus and resistant to scab. Harrow Jubilee is the second of several cucumber cultivars being developed at Harrow for the Ontario pickling cucumber industry.

Peppers

Insect preference in varieties. Repetition of a test with nine bell-type pepper varieties proved that there are differences in natural susceptibility to the European corn borer. Pepper maggot infestation, however, was not significantly related to variety. The outstanding variety was Lady Bell, which had the lowest number of borer-infested fruit in both years, as well as the highest yield both by number and weight. Lady Bell plants were only slightly affected by verticillium wilt (1.7%) whereas almost half the plants of Argo and Big Bertha were lost. A crop management scheme would relate varieties to required protection schedules and marketable yields.

Potatoes

Systemic insecticides. A moderately high level of populations of the Colorado potato beetle caused damage to untreated potatoes, but aldicarb provided excellent control as a preplanting or a side-dressed application. It was also found that application of aldicarb could be reduced to an active ingredient rate of 1.12 kg/ha and still provide good control for the total season of 110 days. This rate, which is half the recommended dose, would alleviate concern about residues in potatoes and reduce the possibility of aldicarb contaminating groundwater.

Sweet corn

Effectiveness of insecticides. Applications of insecticides against second-generation corn borer at 5-day intervals revealed that carbaryl is no longer providing effective control and permethrin has lost some toxicity. A collection of diapausing larvae will provide a laboratory culture for accurate measurement of the level of resistance if it is present. Some synthetic pyrethroids provided excellent control while untreated corn had 76% infested ears.

Maize dwarf mosaic virus. MDMV was found in sweet corn and field corn in Essex County, Ont., from mid-June onwards in 1981 and 1982. This is a new record for Essex County, and in Canada it extends the known range of the virus in southwestern Ontario and southern Quebec. Virus isolates were mechanically transmissible to corn and Johnson grass but not wheat. They comprise particles averaging 741 nm in length, which were transmitted by *Myzus persicae.* Oats and sometimes barley were symptomless carriers of the virus. All 50 sweet corn varieties tested were susceptible to the virus.

Varietal resistance to first-generation corn borer. The 1983 season favored corn borer oviposition with the result that untreated standard varieties had 18% infested ears, almost double the 1982 level. However, cultivars identified as resistant in the past few years remained so, and six new hybrids were added to the group that have less than 5% damaged ears. A comprehensive analysis of the 6-yr data on resistance showed that there was significant variation among cultivars and among years. There was no interaction among cultivars, years, or replicates. A cultivar must be tested for 3 yr for reliable assessment.

Tomatoes

Bacterial speck. To assess the direct effect of temperature on foliar lesion development on plants of tomato cultivar H-2653 immediately following inoculation, plants were maintained in growth chambers under 15 h day length with a 30°C day/23°C night or a 20°C day/13°C night temperature regime. Plants were transferred between the chambers after 1–5 days or remained at the original temperatures for the total duration of 10 days. Plants exposed to the lower temperature regime for the initial 24 h had foliar lesions threefold higher than corresponding plants at the high temperature regime. Lesion numbers increased with increasing duration of the lower temperature regime and decreased with the corresponding high temperature regime. This helps to explain decreased field symptoms observed during hot weather.

Among four antibiotics tested, streptomycin and tetracycline-HCl were effective seed disinfectants, and these together with Kasugamycin were effective therapeutic agents in tomato seedlings whereas tylosin was ineffective. Tetracycline-HCl was the least phytotoxic antibiotic.

Charcoal protection from herbicides. Activated charcoal applied in fine vermiculite in a narrow (6-cm) band over the seeded row just ahead of the press wheel protected the direct-seeded processing-tomato crop (cultivar H-2653) from injury from a preemergence application of metribuzin (0.3 kg/ha) on Fox sandy loam soil. Complete protection from metribuzin at 0.6 kg/ha required three times the amount of charcoal in the vermiculite, but tomato stunting and stand decreases observed with less charcoal were not reflected in a final yield reduction. Charcoal applied at high rates also protected tomatoes from injury from chloramben at 4 kg/ha. Where chloramben injury caused stunting of seedlings, fruit maturity was also delayed. Charcoal caused a reduction in weed control due to inactivation of the herbicide within the row of tomatoes. Further research is necessary to establish a balance between rates of charcoal and herbicide, or to develop charcoal application methods that will allow both optimum crop establishment and effective weed control within the row.

Effect of population density on the yield of field-seeded tomatoes. In attempts at field seeding, tomato growers generally overseed by as much as 800% as a precaution in order to obtain an acceptable stand in the field, especially under adverse soil conditions in early spring. To determine the effect of these high populations on yield, tomato seeds were clump-seeded in rows 1.5 m apart and 30 cm within the row. The highest yields were obtained with 3 seedlings per clump, followed by lower yields from 2, 4, or 5, and the lowest yields from 1 or 10 seedlings per clump. Fruit numbers on each plant declined as populations increased, whereas fruit size was diminished only at the highest plant density.

Irrigation and water use efficiency. Field experiments were conducted from 1979 to 1982 to study the effect of irrigation on yield and water use efficiency of tomatoes. Two cultivars (H-2653 and C-28) were planted in mid-May on Fox sandy loam. Four irrigation treatments consisted of rain-shed (no irrigation or rainfall); no irrigation (rainfall only); irrigation at 25% available soil moisture (ASM); and irrigation at 50% ASM. Seasonal water use by tomatoes was measured using floating lysimeters. There was a good relationship between marketable yields and seasonal accumulated water use. For each 20-mm increase in water use, there was a corresponding yield increase of about 2.8 t/ha. Yield and water use efficiency of both cultivars were increased in a dry season by irrigation. Nonirrigated tomatoes, however, made more efficient use of water during years of normal and above-average rainfall. In the rain-shed plots, a severe water stress situation resulted in reduced seasonal water use, a proportionally larger reduction in yield, and therefore the lowest water use efficiency.

Polyethylene glycol pretreatment of tomato seeds. Polyethylene glycol (PEG) is well known to enhance the rate of germination in seeds. Tomato seeds pretreated with PEG were found to germinate more quickly than untreated seeds, on moist filter paper in petri dishes in incubators. However, in field tests there was no benefit of pretreating tomato seeds with PEG for outdoor sowing. The cause of the lack of promotion of seedling emergence from soil outdoors as compared to germination in petri dishes is not known. It is clear that some tomato lines (for example, PI 341988) have an inherent high vigor and germinate quickly and quite evenly in comparison to commercial cultivars. This genetic potential for rapid germination may help the tomato breeder to provide more vigorous seed germination than can be obtained by any pretreatment of the seed.

Vitamin C development in maturing fresh-market tomatoes. It is generally recognized that with few exceptions the vitamin C content of tomatoes varies among cultivars from a low of about 5 to a high of about 40 mg/100 g of tomato. In the fresh-market tomato breeding program it was found that the vitamin C content of the tomato is high when the fruit is small, declines somewhat as the fruit increases in size, and then begins to increase again as the fruit ripens. For example, fruits of the cultivar TH-318 at the 10-g size contained a vitamin C level of 26.5 mg/100 g of fruit, declining to 20.3 at the green stage and rising to 21.1 when the tomato was ready to be eaten. Most of the vitamin C was in the serum (jelly) portion of the tomato. The flesh portion of the TH-318 tomato had a vitamin C level of 2.4 while the serum portion contained 21.3 mg/100 g at the mature green stage. About 84% of the fruit weight of cultivar TH-318 was in the serum portion. Other cultivars have a much higher level of vitamin C in the flesh portion. These cultivar accessions are being used in the breeding program to improve the vitamin C content of fresh-market tomatoes.

Weed control. Weed control in direct-seeded tomatoes has proved difficult to obtain until the crop reaches the four-leaf stage, at which time metribuzin can be used. Unfortunately, broad-leaved weeds can sometimes be hard to control by this time. In an effort to reduce the time required for tomato plants to reach the stage at which metribuzin can be used, field evaluation of two commercial varieties of processing tomatoes has been conducted for 2 yr with "osmoconditioned" seed. This process allows seeds to imbibe water slowly to initiate germination, but the seeds are redried before the radicle comes through the seed coat; once they are planted, germination begins again. The osmoconditioned seed did not react differently from unconditioned seed to any of the herbicide treatments tested. The osmoconditioned seed had approximately a 12-day advantage and a twofold increase in emergence over the unconditioned seed. The yield advantage obtained from the osmoconditioned seed occurred because of the poor final plant stand of the unconditioned seed. Further research is required to evaluate the conditioning process on large seed batches.

Greenhouse vegetables

Cucumbers

Integrated control of twospotted spider mites. A spray of cyhexatin reduced activity and ovipositional capacity of the predatory mite *Phytoseiulus persimilis*. Since this acaricide has a high toxicity to the twospotted spider mite, a concentration of 0.0075% provided the best balance between numbers of predator and prey mites and led to rapid control. Similar experiments with fenbutatin showed no adverse affects on predators, so the most rapid control was achieved by a comparatively high rate of 0.05% fenbutatin and the usual 25:2 ratio of prey to predator mites.

Integrated crop management. Complex experiments were set up to evaluate the interactions of the chemical, biological, and cultural controls available for the control of fungal diseases, insect pests, and a whitefly-transmitted virus, beet pseudo yellows, in cucumbers. Excellent control of powdery mildews was achieved in cucumbers by foliar sprays of microbial nutrients.

Powdery mildew. Cleistothecia of *Sphaerotheca fuliginea* were found for the first time in Ontario; they confirmed the identity of the powdery mildew hitherto identified only from conidial characters.

Residues of dinocap and EBDC in cucumber fruits. Joint trials were conducted at Harrow with the cooperation of the Ontario Provincial Pesticide Laboratory, Guelph. After three applications of Dikar (72% zineb + 4.4% dinocap) at 1.5 g/L product or of dinocap at 0.625 g/L product, residues of EBDC on cucumber fruits did not exceed the permitted 7 μg/g and residues of dinocap did not exceed the permitted 0.1 μg/g 3 days after the last spray application. The present waiting period in Ontario after the last application of zineb is 5 days, and of dinocap, 30 days.

Tomatoes

Stem rot. An outbreak of stem rot resulting in an average of 18% mortality of bearing tomato vines in two large greenhouses in the Leamington area during the summer of 1983 was diagnosed as being caused by the soft rot bacterium *Erwinia carotovora* subsp. *carotovora*. The disease occurred in several other greenhouses and is new to Ontario. A similar condition occurring sporadically for the past few years in local greenhouses might have been this disease, inasmuch as it had been reported from both of these greenhouses in the previous year.

Tree fruits

Grape

Diseases. In the remarkably hot summer of 1983, a number of white grape cultivars in southwestern Ontario had a bunch rot caused by *Aspergillus aculeatus* Iizuk. It caused serious damage in the cultivars Seyval Blanc, Aurore, Dutchess, and Johannesburg Riesling, but not in the black grape Maréchal Foch. The fungus is a wound pathogen, entering the berry through partial detachment wounds at the stalk end in tight bunches, and through insect punctures. In vitro work suggests that it would be controlled by iprodione.

Peach

Biological control of canker. Six fungal epiphytes with potential as biocontrol agents were isolated from the surface of perennial cankers. *Epicoccum purpurascens*, *Gliocladium roseum*, a *Trichoderma* sp., and a *Cladosporium* sp. were found to inhibit the growth of *Leucostoma persoonii* in culture by direct invasion of mycelium or production of antibiotic substances, or both. *Aureobasidium pullulans* Arnaud and a *Sporobolomyces* sp. were shown to be strongly competitive, yeast-like antagonists.

Breeding. Two late-season, fresh-market peach cultivars were introduced, Harrow Beauty and Harcrest. Harrow Beauty, formerly tested as HW 231, is a very attractive, medium-sized, firm-fleshed, cold-hardy freestone peach that ripens between Canadian Harmony and Loring, about 28 August at Harrow. The fruit is well suited for the fresh market, including local sales and shipping. The tree appears to have moderate field tolerance for perennial canker, caused by *Leucostoma cincta* (Fr.) Höhn and *L. persoonii* (Wits.) Höhn. The foliage and fruit are resistant to bacterial spot, caused by *Xanthomonas campestris* pv. *pruni* (Smith) Young et al., and the flowers and fruit are resistant to brown rot, caused by *Monilinia fructicola* (Wint.) Honey. The fruit is also resistant to split pits, preharvest drop, and flesh oxidation. Harcrest, formerly tested as HW 225, ripens 13 days later than Harrow Beauty, 3 days after Redskin, about 10 September at Harrow. This cultivar is more cold hardy than Harrow Beauty or Redhaven, the hardy standard. The tree is vigorous and has moderate tolerance for perennial canker, the leaves and fruit are resistant to bacterial spot, and the flowers and fruit are resistant to brown rot. Fruit is also resistant to split pits but subject to preharvest drop if hot, dry conditions prevail just before harvest. Harcrest is well suited for the fresh market, including local sales and shipping, and is suitable for preservation at home by canning or freezing. It is intended as a replacement cultivar for Redskin, which is less hardy and ripens 3 days earlier. Harrow Beauty and Harcrest are adapted to regions of southern Ontario where Redhaven is successfully grown.

Endomycorrhizal colonization of rootstocks. Surveys have revealed that endomycorrhizal fungi, particularly *Glomus* and *Gigaspora* species, are widely distributed in the soils of orchards in southern Ontario. These fungi have an ameliorative effect on the growth of plants. Peach roots in local nurseries were found to be extensively colonized by mycorrhizal fungi 6 mo after soil fumigation with the nematicidal dichlorpropane–dichlorpropene mixture. Harrow Blood and Bailey rootstocks had higher levels of colonization than Siberian C at the time of sampling.

Integrated orchard management. An experiment was initiated in 1980 to study the long-term influence of various orchard management practices on peach production. There were three cultivars, Garnet Beauty (early season), Harbrite (midseason), and Canadian Harmony (late season); two kinds of ground cover management, either the standard practice of temporary cover from July to April and clean cultivation from April to July, or a permanent sod of creeping red fescue; and two soil moisture practices, consisting of either no supplemental irrigation or season-long trickle irrigation from mid-May to early September. The first full commercial crop was produced in 1983 in the fourth growing season. Cultivars differed significantly in total yield, with Canadian Harmony having the highest yield (20.2 t/ha) whereas Harbrite and Garnet Beauty averaged 15.1 and 14.7 t/ha, respectively. Average yields under temporary ground cover were 16% higher than under permanent sod. Average yields under trickle irrigation were 33% higher than under no irrigation. This orchard was planted at a moderately high density (641 trees/ha), which explained the generally high yields obtained in the first year of production. The growing season was hot and the weather was dry in July and August, which accounted for the large response in yield from trickle irrigation.

Pear

Rootstocks. Fruit production of Bartlett and Harvest Queen pears were compared on four clonal *Pyrus communis* rootstocks, Old Home × Farmingdale (OH × F); one quince (Quince A); and standard Bartlett seedlings. Bartlett produced the highest accumulated (1979–1983) yields on Quince A (30.7 kg/tree), followed by OH × F 87 (26.7 kg/tree), and only yielded 20.2 kg/tree on Bartlett seedlings. Harvest Queen had the highest yields on OH × F 87 (38.7 kg/tree), followed by OH × F 69 (34.5 kg/tree), and only produced 18.9 kg/tree on Bartlett seedlings. Fruit size was generally greater on the clonal rootstocks than on Bartlett seedlings.

PUBLICATIONS

Research

Anderson, T. R.; Welacky, T. W. 1983. Barn mold of burley tobacco caused by *Botryosporium longibrachiatum*. Plant Dis. 67:1158-1159.

Anderson, T. R.; Welacky, T. W. 1983. Sensitivity of burley tobacco cultivars to weather fleck in Ontario. Plant Dis. 67:66-68.

Aylesworth, J. W.; Tu, J. C.; Buzzell, R. I. 1983. Sanilac BC6-Are white bean breeding line. HortScience 18:115.

Ben-Ze'ev, I. 1982. *Erynia neopyralidarum* sp. nov. and *Conidiobolus apiculatus*, pathogens of pyralid moths components of the misdescribed species, *Entomophthora pyralidarum* (Zygomycetes: Entomophthorales). Mycotaxon 16:273-292.

Devine, T. E.; Palmer, R. G.; Buzzell, R. I. 1983. Analysis of genetic linkage in the soybean. J. Hered. 74:457-460.

Dhanvantari, B. N. 1983. Etiology of grape crown gall in Ontario. Can. J. Bot. 61:2641-2646.

Dhanvantari, B. N.; Dirks, V. A. 1983. An evaluation of peach cultivars and selections for resistance to *Leucostoma cincta*. Can. J. Plant Sci. 63:307-310.

Foott, W. H.; Timmins, P. R. 1982. Injury to grain corn by the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), in southwestern Ontario, 1977–1981. Proc. Entomol. Soc. Ont. 113:17-20.

Foott, W. H.; Timmins, P. R. 1983. The severity of stalk rot of grain corn in relation to infestations of a bivoltine strain of the European corn borer, *Ostrinia nubilalis* (Lepidoptera: Pyralidae). Can. Entomol. 115:1235-1237.

Gates, L. F. 1983. Maize dwarf mosaic in Essex County, southwestern Ontario, 1981–82. Can. J. Plant Pathol. 5:129-132.

Gaynor, J. D.; Hamill, A. S. 1983. Bentazon preemergence activity on velvetleaf (*Abutilon theophrasti* Medic) and persistence in southwestern Ontario soils. Can. J. Plant Sci. 63:1015-1022.

Jarvis, W. R. 1983. Progress in the biological control of plant diseases. 10th Int. Congr. Plant Prot. pp. 1095-1105.

Jarvis, W. R.; Thorpe, H. J. 1983. The control of Fusarium crown rot in tomatoes by lettuce intercropping. 10th Int. Congr. Plant Prot. pp. 797-798.

Jarvis, W. R.; Thorpe, H. J.; Meloche, R. B. 1983. Survey of greenhouse management practices in Essex County, Ontario, in relation to Fusarium foot and root rot of tomato. Plant Dis. 67:38-40.

Kappel, F.; Flore, J. A.; Layne, R. E. C. 1983. Characterization of the light microclimate in four peach hedgerow canopies. J. Am. Soc. Hortic. Sci. 108:102-105.

Layne, R. E. C. 1983. Hybridization techniques. Pages 48-64 *in* Moore J. N., and Janick, J., eds. Methods in fruit breeding. Purdue Univ. Press. 464 pp.

Levin, D. B.; Laing, J. E.; Jaques, R. P.; Corrigan, J. E. 1983. The transmission of granulosis virus of *Pieris rapae* by the parasitoid *Apantelus glomatatus*. Environ. Entomol. 12:166-170.

Liptay, A.; Geier, T. 1983. Mechanism of emergence of tomato (*Lycopersicon esculentum* L.) seedlings through surface-crusted or compressed soil. Ann. Bot. 51:409-412.

Liptay, A.; Schopfer, P. 1983. Effect of water stress, seed coat restraint, and abscisic acid upon different germination capabilities of two tomato lines at low temperature. Plant Physiol. 73:935-938.

McClanahan, R. J.; Founk, J. 1983. Toxicity of insecticides to the green peach aphid (Homoptera: Aphididae) in laboratory and field tests, 1971–1982. J. Econ. Entomol. 76:899-905.

Pandeya, R. S.; Dirks, V. A.; Poushinsky, G. 1983. Quantitative genetic studies in flue-cured tobacco (*Nicotiana tabacum*). I. Agronomic characters. Can. J. Genet. Cytol. 25:336-345.

Papadopoulos, A.; Tiessen, H. 1983. Root and air temperature effects on the flowering and yield of tomato. J. Am. Soc. Hortic. Sci. 108:805-809.

Quamme, H. A. 1983. Relationship of air temperature to water content and supercooling of overwintering peach flower buds. J. Am. Soc. Hortic. Sci. 108:697-701.

Quamme, H. A.; Spearman, G. A. 1983. 'Harvest Queen' and 'Harrow Delight' pear. HortScience 18:770-772.

Reid, W. S.; Liptay, A.; Nicholls, C. F.; Marriage, P. B. 1983. A plug-mix planter attachment for dispensing charcoal vermiculite mixture to protect emerging seedlings from herbicide toxicity. Can. J. Plant Sci. 63:567-571.

Sears, M K.; Jaques, R. P; Laing, J. E. 1983. Utilization of action thresholds for microbial and chemical control of lepidopterous pests on cabbage. J. Econ. Entomol. 76:368-374.

Stone, J. A.; Kaspar, T. C.; Taylor, H. M. 1983. Predicting soybean rooting depth as a function of soil temperature. Agron. J. 75:1050-1054.

Stone, J. A.; Taylor, H. M. 1983. Temperature and the development of the taproot and lateral roots of four indeterminate soybean cultivars. Agron. J. 75:613-618.

Tan, C. S.; Fulton, J. M.; Nuttall, V. W. 1983. The influence of soil moisture stress and plant populations on the yield of pickling cucumbers. Sci. Hortic. 21:217-224.

Teich, A. H. 1983. Genotype – environment interaction variances in yield trials of winter wheat. Cereal Res. Commun. 11:15-20.

Traquair, J. A.; Kokko, E. G. 1983. Urediniospore morphology of *Puccinia* species attacking Carduae. Can. J. Bot. 61:2047-2051.

Tu, J. C. 1983. Efficacy of iprodione against alternaria black pod and white mold of white beans. Can. J. Plant Pathol. 5:133-135.

Tu, J. C. 1983. Epidemiology of anthracnose caused by *Colletotrichum lindemuthianum* on white bean (*Phaseolus vulgaris*) in southern Ontario: Survival of the pathogen. Plant Dis. 67:402-404.

Tu, J. C. 1983. Inheritance in *Phaseolus vulgaris* cv. Kentwood of resistance to a necrotic strain of bean yellow mosaic virus and to a severe bean strain of tobacco ringspot virus. Can. J. Plant Pathol. 5:34-35.

Walker, A.; Hance, R. J.; Allen, J. T.; Briggs, G. G.; Chen, Y.-L.; Gaynor, J. D.; Hogue, E. J.; Malquori, A.; Moody, K.; Moyer, J. R.; Pestemer, W.; Rahman, A.; Smith, A. E.; Streibig, J. C.; Torstensson, N. T. L.; Widyanto, L. S.; Zand voort, R. 1983. EWRS Herbicide–soil working group. Collaborative experiment on simazine persistence in soil. Weed Res. 23:373-383.

Weaver, S. E.; Lechowics, M. J. 1983. The biology of Canadian weeds. 56. *Xanthium strumarium* L. Can. J. Plant Sci. 63:211-225.

Weaver, S. E.; Tan, C. S. 1983. Critical period of weed interference in transplanted tomatoes (*Lycopersicon esculentum*): Growth analysis. Weed Sci. 31:476-481.

Miscellaneous

Jaques, R. P. 1983. Potential of pathogens for pest control. Agric. Ecosyst. Environ. 10:101-126.

Jarvis, W. R. 1983. Onion neck rot. Ontario Ministry of Agriculture and Food Factsheet 83/047 (revised).

McClanahan, R. J. 1983. Control of *Liriomyza trifolii* on greenhouse chrysanthemums. Bull. SROP/WPRS V1/3:116-123.

McClanahan, R. J. 1983. Parasites and predators for control of greenhouse pests. Canadex 614.

Papadopoulos, A. 1982. Peat bags for greenhouse tomatoes. Can. Agric. 28(4):20-23.

Swanton, C. J.; Hamill, A. S. 1983. Jerusalem artichoke. Agdex 642.

Traquair, J. A.; Lebeau, J. B.; Moffatt, J. E.; Kokko, E. G. 1983. Northern distribution of LTB snow mold in Canada. Can. Plant Dis. Surv. 63:1-2.

Tu, J. C. 1983. Virus diseases of white beans. Canadex 142.630.

Weaver, S. E. 1983. Cocklebur. Agdex 640.

Weaver, S. E.; Riley, W. R. 1983. Field bindweed. Agdex 642.

Research Station
Ottawa, Ontario

PROFESSIONAL STAFF

T. Rajhathy, Ing. Agr., M.Sc., D.Agr.Sci., F.R.S.C.	Director
J. G. R. Loiselle, B.Sc. (Agr.), M.Sc., Ph.D.	Plant gene resources of Canada
R. Porteous	Head, Administration and resources
C. McCarthy	Finance and general services
R. Running	Personnel services

Cereal Crops

V. D. Burrows, B.S.A., M.Sc., Ph.D.	Head of Section; Oat breeding
V. Clark, B.Sc. (Agr.), M.Sc., Ph.D.	Oat and barley pathology
J. Frégeau, B.Sc., M.Sc., Ph.D.	Crop physiology
R. G. Fulcher, B.Sc., M.Sc., Ph.D.	Morphogenetics and grain quality
K. M. Ho, B.Sc., M.Sc., Ph.D.	Barley breeding
D. R. Sampson, B.Sc., A.M., Ph.D.	Wheat breeding
W. L. Seaman, B.Sc., Ph.D.	Wheat pathology

Cytogenetics

G. Fedak, B.S.A., M.Sc., Ph.D.	Head of Section; Cereal cytology
K. C. Armstrong, B.S.A., Ph.D.	Brome cytology and chromosome banding
I. L. Craig, B.S.	*Hordeum* cytology
B. E. Murray, B.S.A., M.Sc., Ph.D.	Haploidy—flax cytology

Entomology

D. G. Harcourt, B.S.A., Ph.D.	Head of Section; Population dynamics
R. Boch, Dr. Rer. Nat.	Physiology and behavior of bees
T. A. Gochnauer, B.S., M.S., Ph.D.	Pathology of bees
J. C. Guppy, B.S.A., M.S.	Population dynamics
C. C. Loan, B.A., M.S., Ph.D.	Population dynamics

F. Meloche, B.Sc., M.Sc.	Population dynamics

Forage Crops

R. I. Hamilton, B.Sc., M.S.A., Ph.D.	Head of Section; Corn breeding
P. K. Basu, B.Sc., M.Sc., Ph.D.	Plant disease
M. A. Faris, B.Sc., M.Sc., Ph.D.	Legume breeding
A. R. McElroy, B.Sc., M.Sc., Ph.D.	Grass breeding
H. D. Voldeng, B.S.A., M.Sc., Ph.D.	Soybean breeding
F. S. Warren,[1] B.S.A., M.Sc., Ph.D.	Agronomy

Genetic Engineering

W. A. Keller, B.S.A., Ph.D.	Head of Section; Cell genetics
D. Brown, B.Sc., M.Sc., Ph.D.	Developmental physiology
B. L. A. Miki, B.Sc., Ph.D.	Molecular genetics
S. J. Molnar, B.Sc., M.Sc., Ph.D.	Cell genetics

Ornamentals

A. T. Bolton, B.Sc., M.Sc., Ph.D.	Head of Section; Pathology
S. Nelson, B.Sc., M.Sc., Ph.D.	Nursery research
E. V. Parups, M.S.A., Ph.D.	Physiology and floriculture
J. A. Simmonds, B.Sc., M.Sc., Ph.D.	Physiology and floriculture
F. Svejda, Ph.D.	Plant breeding

Experimental Farm, Kapuskasing, Ont.

J. G. Proulx, D.V.M.	Superintendent; Crop and beef management

Experimental Farm, Thunder Bay, Ont.

J. Wilson	Superintendent; Crop management and evaluation

Departure

B. W. Jablonski, B.L.A. Retired March 1983	Landscape Architect

VISITING SCIENTISTS

B. Giles, B.Sc., M.Sc., Ph.D. From June 1981 to June 1983	*Hordeum* cytogenetics
L. A. Holbrook, B.Sc., M.Sc., Ph.D. From April 1983 to March 1984	Genetic engineering of plants
K. Klimaszewska, M.Sc., Ph.D. From December 1981 to November 1984	Tissue culture
M. W. Zink, B.Sc., M.Sc., Ph.D. From July to October 1983	Molecular genetics

Graduate student

S. Gleddie, B.Sc.	Somatic hybridization

---

[1] On a Canadian International Development Agency (CIDA) assignment to Sri Lanka from September 1982 to December 1983.

INTRODUCTION

The Ottawa Research Station is the major center for plant breeding in eastern and central Ontario. It is a major center for ornamentals research, biotechnology for crop improvement, and integrated management of alfalfa pests. A small unit is engaged in studies of honey bee behavior and pathology. The central office for the Canadian Plant Gene Resources is part of the Station. The management of the Central Experimental Farm, including numerous services, is also the Station's responsibility.

The breeding programs are supported by multidisciplinary research in plant, molecular, and cell genetics, cytogenetics, plant physiology and pathology, entomology, cytochemistry, and grain quality. The Experimental Farm at Kapuskasing continues to conduct experiments on crop production and on beef cattle management, in cooperation with the Animal Research Centre (Ottawa), for northwestern Quebec and northeastern Ontario. The Experimental Farm at Thunder Bay is concerned with methods of crop production for northwestern Ontario.

The Station has maintained its traditional productivity. Both of our short-season breeding programs have become truly national in scope: of the six new corn hybrids supported for licensing, two are for Ontario, one for the Maritimes, two for Manitoba, and one for Alberta; and of the three new soybean cultivars, one was recommended for the Maritimes and one for Manitoba.

Our landscape architect, Mr. Bob Jablonski, retired after 18 years of distinguished service. His creative insight and perfectionist execution will be seen at the Central Experimental Farm as well as at many research stations across the country for many years to come.

This report summarizes some of the more important research results from the Station in 1983. Further information can be obtained from the publications listed at the end of this report. Reprints of the research publications and copies of this report are available on request from the Ottawa Research Station, Research Branch, Agriculture Canada, Ottawa, Ont. K1A 0C6.

Tibor Rajhathy
Director

CEREAL CROPS

Wheat

Breeding. All the winter wheat yield trials and one-third of the nurseries were destroyed at the Ottawa Research Station (ORS) by an unprecedented number of winter rains and ice accumulation on the plots. Over 140 of the most promising F_4 and F_5 lines were salvaged by vernalizing reserve seed and transplanting seedlings to the field in the spring. A spring wheat line, Ottawa 5381-9, developed here over 30 yr ago, was one parent in the last cross that gave two new Quebec cultivars: Casavant (1980) and Mondor (1983). Ottawa 5381-9 probably contributed *Fusarium* resistance from its ancestor Frontana.

Genetics. A cross between two experimental spring wheat lines, Cal 13 (very hard kernels, semidwarf plants) and Cal 25 (hard kernels, tall plants), showed a highly significant correlation of $r = 0.57$ between kernel hardness and plant height. The semidwarf plants in the progeny had the dwarfing gene *Rht* 2 and tended to have extra-hard kernels, suggesting that the genes for the two traits are on the same chromosome.

Physiology. Preharvest sprouting resistance of entries in the Ontario Winter Wheat Cooperative Test was evaluated according to three protocols. Sprouting percentages from exposure of heads to natural rain were lower than the ones obtained in a rain simulator, although ranking of the cultivars in the two tests was almost identical. Fredrick had the lowest sprouting level and Houser again had the highest level. Ranking of the entries according to rate of germination of the threshed grains (promptness index) closely followed the pattern observed in the rain tests. Weather conditions during maturation of the grains in Ottawa were warmer and drier than normal, which was not favorable for the development of embryo dormancy. This was especially true for the lines in the ORS dormancy breeding program. No marked difference could be observed between lines grown from 1982 material preselected for sprouting resistance and identical unselected material.

Pathology. In 1982, powdery mildew (*Erysiphe graminis* DC. ex Mérat) and barley yellow dwarf virus (BYDV) were prevalent in fields of winter wheat seeded in early autumn in southern Ontario. Winter survival of the crop was excellent; snow mold damage was negligible, and survival in the main growing area averaged 95%. In eastern and northwestern areas, some damage from flooding and icing was experienced. Aphid activity was light until midseason and although BYDV was widespread, it was only locally severe. Wheat spindle streak mosaic was prevalent and severe in soil-infested areas in southeastern Ontario, and foot and crown rots were widespread. Hot dry weather from mid-June through harvest prevented the establishment of fusarium head blight [*Gibberella zeae* (Schw.) Petch.], which was reduced to trace levels. Vomitoxin levels were not of concern and below detectable levels in most of the crop areas. Screening tests at Ottawa identified lines of wheat with resistance to prevailing strains of leaf rust (*Puccinia recondita* Rob. ex Desm.), powdery mildew, and loose smut [*Ustilago tritici* (Pers.) Rostr.].

Barley

Breeding. Léger, a six-rowed feed barley licensed in 1982, represents a new level of excellence in spring barley in Eastern Canada. It has consistently exhibited exceptionally high yield, good test weight, large kernel size, and strong straw, and large quantities of certified seed will become available in 1984. A backcrossing program to incorporate a higher level of mildew resistance into Léger is nearing completion. Another productive strain (OB490) is performing well and is being evaluated for the 2nd yr in the Eastern Cooperative Test. The new barley breeding program to breed short- and strong-strawed, large-seeded two-rowed cultivars is progressing satisfactorily and new lines will be evaluated in advanced tests in 1985.

Pathology. Net blotch [*Pyrenophera teres* (Died.) Drechsl.] and scald [*Rhynchosporium secalis* (Oud.) Davis] were the important diseases affecting barley in Ontario. Leaf stripe (*Pyrenophora graminea* Ito & Kurib.) was reported in 1982 in Ontario for the first time in many years. Tests (1983) showed that the fungus was present at levels of 0.1–3% in seed stocks produced for evaluation in cooperative tests, in trace amounts in winter barley plants grown at two test sites in southern Ontario, and in spring barley at one site each in southern and northern Ontario. Treatment of infected seed with maneb flowable formulation was less effective than using maneb wettable powder and several systemic fungicides in controlling the disease. Stripe can survive only in infected seed, so it must be treated with effective chemicals and seed plots rogued to prevent the spread of the disease in Eastern Canada.

Oats

Breeding. ORS continues to breed oats for feed and food (milling) purposes. Donald, released in 1982, is gaining popularity in Ontario because of its high yield, large seed size, thin hull (high hectolitre weight), low losses during cleaning, and early maturity. Donald has been further improved by the addition of genes for resistance to crown rust. The new naked-seeded oat OA501-1 has outperformed the cultivar Terra by 5–15% in various tests and will be licensed (1985) if it continues to perform well. Chevron-type dwarf oats, which possess exaggerated multifloreted spikelets, failed to yield as much grain as Terra because of small seed size but new hybrids have been made to solve this problem.

Physiology. A field experiment was initiated (1982) to estimate winter survival of some selected strains of dormoats subjected to induction of secondary dormancy. Four strains responded well to the treatment, as reflected in their better spring emergence in the field. Laboratory performance paralleled that observed in the field. Results indicate that the disappearance of dormancy might be linked to exposure of the soaked seeds to cycles of wet and dry conditions. The effect of the state of afterripening of the seeds on successful induction was investigated in the fall of 1983. Results indicate that afterripening needs to be overcome before induction is effective.

Pathology. Oat infection by crown rust (*Puccinia coronata* Cda.) and black stem disease (*Septoria avenae* Frank f. sp. *avenae*) ranged from light to moderately severe and BYDV was prominent in late-seeded oats. Intensive management tests with oats alone and in mixtures with barley showed that extra N increased seed yields and protein content but not kernel weight. Treatments with cycocel growth retardant and propiconazole (Tilt) fungicide applied to the foliage resulted in little improvement in performance. There was a suggestion of an interaction between fungicide application and extra N which had the effect of reducing seed protein content. Donald oats and Léger barley performed extremely well in mixtures.

Grain quality and microchemistry. Initial studies on the fate of deoxynivalenol (vomitoxin) in soft white winter wheats and wheat products were extended to provide similar data on spring and winter wheats from Quebec and the Maritimes. Significant reduction in both vomitoxin and ergosterol levels were noted in flours. These data indicate that there is a marked gradation in fungal metabolite distribution within *Fusarium*-infected grains. Preliminary collaborative studies with the Chemistry and Biology Research Institute indicate that an additional *Fusarium* toxin, zearalenone, was detectable by fluorescence analysis. Studies were begun to evaluate the distribution of mixed-linkage β-glucans in wheat and mill streams. Unlike barley and oats, in which the β-glucans are uniformly distributed throughout the starchy endosperm, in wheat the β-glucans occur in very high concentration near the crease and aleurone layers but are almost nonexistent in the mid-endosperm.

CYTOGENETICS

Cereal cytogenetics

Intergeneric hybrids were obtained by crossing *Triticum turgidum* L. var. *dicoccoides* (Körn. in litt. in Schweinf.) Bowden ($2n = 4x = 28$) onto *Hordeum chilense* Roemer & Schultes ($2n = 2x = 14$). The latter is a perennial species from Chile where it grows in a variety of habitats ranging from alluvial soils on the seashore to fertile meadows in the Andes Mountains. Hybrid seedlings were produced, through embryo rescue techniques, at the rate of 1.2% of pollinated florets. The hybrid plants resembled the *Triticum* parent, with no obvious influence of the *Hordeum* parent as in all other *Triticum–Hordeum* hybrids produced to date. The hybrid plants had 21 chromosomes and were completely sterile. Mean chromosome associations per cell in the hybrid were $0.47'' + 20.06'$, indicating no expression of homoeology between parental genomes. Colchicine treatments were effective in inducing chromosome doubling to produce the fertile amphiploid with a chromosome number of $2n = 42$. The latter were vigorous plants with normal chromosome behavior and good fertility, producing seed that resembled that of the paternal parent.

In order to produce single chromosome addition lines of *H. chilense* in *T. turgidum*, the latter, and cultivars Madoc and Stewart 63 of *T. durum* Desf., were backcrossed onto the amphiploid. Normal seeds that required no embryo rescue were obtained at frequencies of 8.3–10.1% of pollinated florets.

Chromosome numbers in the BC_1 progeny were $2n = 35$, as expected. Mean chromosome pairing in the BC_1 progeny consisted of 13.1–13.7 bivalents and 7.5–8.8 univalents, which approximated the $14'' + 7'$ that was expected. Chromosome numbers in BC_2 progeny ranged from 28 to 35 and the backcrossing and isolation of addition lines are continuing.

Chromosome banding

Chromosome banding of meiotic chromosomes in a *Secale cereale* L. × *Agropyron trichophorum* hybrid indicated that all bivalents ($x = 3.73$) involved *Agropyron* chromosomes. No recombination between *Agropyron* and *Secale* chromosomes would be expected in this hybrid.

Giemsa staining differentiated between the parental chromosomes in the F_1 hybrid *Bromus latiglumis* Hitch. ($2n = 14$) × *B. arvensis* L. ($2n = 14$). From this it was determined that the chromosome complement of *B. arvensis* was longer than that of *B. latiglumis* and therefore probably contained more DNA than the latter.

Bromus cytogenetics

Chromosome pairing in *B. riparius* Rehm. ($2n = 10x = 70$) approximates 35 bivalents (one or two quadrivalents are found) and in F_1 hybrids ($2n = 9x = 63$) from *B. riparius* × *B. inermis* Leyss. it approximates 7 I + 28 II.

The hybrids were fertile and there appears to be opportunity to transfer desirable agronomic traits from *B. riparius* to *B. inermis*.

Hexaploid and tetraploid cytotypes of the *B. ramosus* Huds. complex exhibit chromosome pairing characteristic of alloploids. Chromosome pairing in pentaploid hybrids was 7 I + 14 II, which indicated that the two cytotypes do possess two genomes in common (e.g. AABB, AABBCC).

Crosses of the annual species *B. arvensis* L. with two diploid (*B. latiglumis* Hitch., *B. ciliatus* L.), and one tetraploid (*B. pacificus* Shear.) species from North America yielded one hybrid, *B. latiglumis* × *B. arvensis*, by embryo culture. The hybrid was sterile and chromosome pairing was incomplete (11.80 I + 1.08 II + 0.01 III).

Hordeum cytogenetics

Comparative analysis of diploid *Hordeum* species based on distinctive markers in their chromosome karyotypes includes several hitherto unexplored diploids. *H. chilense* (Roemer & Schultes) has one pair of distinctive satellited chromosomes (satellite is longer than central segment of the chromosome arm), two pairs of subterminal chromosomes (one longer pair), two pairs of long submedian chromosomes, and two pairs of shorter submedian chromosomes. The satellites of *H. chilense* are similar to the satellites found in *H. californicum* (Covas & Stebbins) but there are differences in the other 12 chromosomes. *H. depressum* (Scribner & Smith) Ryberg has a karyotype fairly similar to that of *H. californicum*. *H. magellanicum* (Parodi & Nicora) Bothmer et al., *H. pubiflorum* (Hook. f.), and *H. patagonicum* (Hauman) Covas s.l. each have two pairs of satellites that are similar, but distinctive from the other species examined. The other difference with these three species is the one pair of near-median chromosomes.

Selection of *H. bulbosum* L. in relation to plant type (erect or prostrate, large or small bulb, tall or short, and so forth) has proven to be a method of describing or identifying *H. bulbosum* plant types or lines. Data are accumulating on plant morphology, distribution, and suitability for crossing using *H. bulbosum* as the pollen donor or female. This project attempts to evaluate and find the most effective and efficient method of exploiting the cytogenetic potential of this important species.

Maintenance and preservation of *Hordeum* germ plasm continue, but the emphasis has shifted toward ensuring that the required seeds and information on ploidy level are available for every accession. Massive screening has now been completed.

ENTOMOLOGY

Population dynamics

Alfalfa weevil. Populations of alfalfa weevil in southern Ontario eroded still further in 1983, continuing the steady decline that began in 1978. In the Bay of Quinte area, life table studies showed that attacks by first-brood *Microctonus aethiopoides* (Loan) at the end of May reduced egg deposition by 26%. During early June, disease infections caused by *Erynia* spp. destroyed 45% of the feeding larvae and in late June, 12% of the cocooned stages. A further 10% of the prepupae were killed by *Bathyplectes anurus* (Thom.) which appears to have displaced *B. curculionis* (Thom.) throughout most of the area. In early July, nearly one-quarter of the summer adults were found to contain larvae of *M. colesi* (Drea) and prior to aestivation about one-third were attacked by second-brood *M. aethiopoides*. Generation survival increased to 10%, signaling a moderate population upturn; this reversal in trend is not expected to lead to economically significant population levels in 1984.

An appraisal of numerical change for the 5-yr period 1978–1982 showed that the relative population stability now experienced is a function of the combined activity of disease and the *Microctonus* parasites. Disease, which appears to act in a density-dependent manner, has the most important influence and accounts for approximately 73% of the variation in population trend. The *Microctonus* parasites contribute an additional 16% of the variation but act in a density-independent manner, because their relatively smaller effect is spread out over a wide range of population densities and they respond to changes in host density rather than cause them; nonetheless, they were responsible for an overall reduction of 50% in generation survival.

A bivoltine strain of the weevil has been detected recently in parts of eastern Ontario. It is proposed that natural selection for a second generation may have occurred as a result of continuous pressure from the fungi and parasites. These organisms confer an advantage to weevils that develop sufficiently early in the season to escape disease epizootics and sterilization as adults by *M. aethiopoides*. Such weevils are gravid by early July. For larvae developing in late summer, parasites are rare and rates of disease are low, giving the population a high probability of success; fall adults enter winter at a younger age than their summer counterparts and may be fitter and more fecund in spring.

Alfalfa blotch leafminer. The alfalfa blotch leafminer has now spread throughout Ontario. In 1983, continuing life table studies confirmed that populations in eastern Ontario, where infestations were first detected, have begun to decline owing to a growing array of natural enemies; the most influential is *Dacnusa dryas* (Nixon), which has been imported, propagated, and extensively released by ORS. In 1983, this larval–pupal parasite destroyed 56% of the population at two sites in the Ottawa valley. Also important were predators (nabids and mirids), which destroyed roughly 38% of the feeding larvae, and competition by the larvae for space and resources within the leaflets, which caused a further shrinkage of 14%. Generation survival averaged 2%; this compared with a mean of 6% for study plots in central and western Ontario where *D. dryas* is not a factor.

Integrated pest management

A polynomial function has been developed for predicting this seasonal occurrence of the leafminer together with biological events germane to its management in southern Ontario. Predictions generated by this model were more accurate than those obtained by the heat unit method and risk estimates were substantially lower. In addition, it was found to be more computer-compatible. The development of this function has enabled coupling of the leafminer software package to that of the weevil in the current SIMWEEVIL/SIMABL directory. In 1983, the remote delivery system was expanded to include additional dairy farms in eastern Ontario; over 600 ha of forage alfalfa were monitored by field scouts on a regular basis.

A field nursery for *D. dryas* has been maintained at Ottawa for several years. In 1982 and 1983, shipments were made to field scouts for release at several sites in southern Ontario; in 1983, successful establishment was recorded in the Quinte area.

Preliminary studies on harvesting strategies showed that cutting at the early-bloom stage had no appreciable effect on the survival of leafminer populations. Cutting at midbud reduced survival by three-quarters and at late bud, by one-half.

Honey bees

Worker honey bees have long been known to respond to specific odors given off by their queens or by other workers, or to extracts from pollen and other food materials. Less well known is their response to odors from diseased larvae. The "foul" odor of American foulbrood disease, caused by *Bacillus larvae* (White), is composed of a mixture of volatile sulfur-containing compounds and of odorous fatty acids, and produces a distinct avoidance reaction in worker bees foraging for food. However, once accustomed to the odor, the workers favor food supplies thus scented. Hive bees are also responsive to the odor, and rapidly remove inert substances in the combs that contain it. Electrophysiology studies have shown that the adult antennae are highly responsive to the scent.

FORAGE CROPS

Alfalfa

Adapted alfalfa germ plasm with genes for resistance to phytophthora root rot (PRR) and bacterial wilt (BW) was screened under greenhouse conditions for verticillium wilt (VW). Forty clones were identified as resistant to VW. A satisfactory technique for screening plants for VW resistance was developed. A conidial suspension of *Verticillium albo-atrum* Reinke & Berth. is used to inoculate 6-wk-old plants (roots and tops cut back) by the dipping technique. The selected plants are screened again 6 wk later using the same procedure to eliminate escapes.

The epidemiological study has been successfully started. A technique for increasing the fungal pathogen under laboratory conditions was established to produce 80 L of the conidial suspension. Also, a technique to inoculate the field experiment was developed. VW symptoms were apparent in the field 6 wk after inoculation, and the experimental area was reinoculated to guarantee the establishment of the fungus.

Six isolates of *Phytophthora megasperma* Drechsler f. sp. *medicaginis* were tested individually for their levels of virulence on 15 alfalfa cultivars having varying degrees of PRR resistance. Stability parameters of a disease severity index were studied following Eberhart and Russell's regression technique. Only three cultivars possessed stable resistance to PRR. Some others had a high level of resistance to the mildly virulent isolates but they were severely infected by the more highly virulent isolates. Two cultivars were relatively susceptible to all the isolates.

It was clear that there are two levels of virulence. The importance of interactions affecting infection by the isolates of *P. megasperma* f. sp. *medicaginis* on alfalfa cultivars is highlighted in this work.

Yield data from the progeny trials were obtained and used to select new entries to form new alfalfa and red clover synthetics. One new alfalfa synthetic (OT-83/3) and one double-cut red clover (OT-83/1) were entered in the 1983 Ontario Forage Crops Committee (OFCC) yield trials. Poly Sc 2 alfalfa has shown excellent winterhardiness and good yields. Creeping alfalfa entries are being evaluated.

Nitrogen-fixing ability was used in red clover selections, resulting in one new synthetic.

Alfalfa subpopulations that were selected for high and low levels of N_2 fixation were again evaluated after three selection cycles. A fourth cycle of recurrent selection for high and low efficiency of N_2 fixation is under way. Grass plants did not show any detrimental effects on the associated legume plants when grown in mixtures; on the contrary, they may stimulate additional N_2 fixation. The transfer of N from alfalfa roots to grass was not primarily due to the death of roots and nodule excretion during the period before initial harvest.

Four alfalfa harvesting schedules were compared on six cultivars in a split plot design. The schedules were three cuttings at early bloom (S_1) or at bud stage (S_2); and combinations of two cuttings at bud stage and one cut at midbloom as cut 1 (S_3) or as cut 2 (S_4). Highest dry matter (DM) yields (9777 kg/ha) and crude protein (1877 kg/ha) were obtained in S_1; the yields of S_3 and S_4 were only slightly lower, but those of S_2 were significantly lower ($P < 0.05$). Forage produced from all the schedules was high in crude protein (17.7–20.5%). In vitro digestibility of DM was inversely related to acid detergent fiber and acid detergent lignin. Data on DM yield of cut 1 (at early bloom) in 1982 suggested that Angus, Vernal, and Iroquois cultivars have better potential for maintaining stand vigor than Algonquin, Thor, and Saranac. These data also suggested that for good stand vigor, cut 3 taken at the end of August or later must be at early bloom or later stage of maturity.

Pathology. An isolate of *V. albo-atrum* from alfalfa (*Medicago sativa* L.) was tested for its viability on nylon threads and in alfalfa stems buried in sterile or nonsterile soil plates for 6 and 12 mo, respectively, at temperatures ranging from −5 to 35°C. Saprophytically the pathogen survived for 5 mo in nonsterile soil at −5 and 5°C, and for 6 mo in sterile soil at −5 to 25°C. Parasitically in alfalfa stems, it survived best (at least 12 mo) without the association of soil through a wide temperature range (−5 to 35°C) or at low temperatures (−5 and 5°C) in soil. At higher soil temperatures the longevity of the pathogen was progressively reduced: 11, 8, and 7 mo at 15, 30, and 35°C, respectively. Dark resting mycelia of the fungus were found consistently in alfalfa tissues, confirming that these served as survival structures.

Grasses

The grass breeding program is concerned with cultivar development and the evaluation of breeding techniques for autopolyploid forages. The principal selection criteria for timothy and bromegrass are in vitro digestibility (IVD) and DM yield. Two synthetics exceeded the check cultivar Climax in both criteria in the 1st yr of testing and are being advanced to provincial testing trials.

Considerable variation for both IVD and DM yield was found among progenies of broadcast-seeded timothy. There is no evidence of any genetic correlation between these two traits. Extensive progeny testing of both bromegrass and orchardgrass is in progress. Orchardgrass is being evaluated as a pasture species. Plots are defoliated frequently to identify lines with a more uniform DM production during the grazing season.

An initial evaluation of switch grass (*Panicum virgatum* L.) suggests this species has considerable potential for use in pastures. Because of its C-4 type of photosynthetic system, it grows most actively in midsummer when the temperate species are least productive. Four cultivars with excellent winterhardiness were identified. Within each there was wide variation for plant type and maturity. Superior plants were identified for progeny testing. Indigenous plants were collected from southern Ontario. Studies on parental selection techniques, recurrent selection, and the use of simulated swards for genotype evaluation are in progress. A field generation-advance nursery proved very promising in its 1st yr of evaluation. This technique is designed to overcome a major bottleneck in forage grass breeding, namely, the advancement of large numbers of synthetics to the second generation (Syn-2). Further work on the degree of pollen control obtained with this technique is in progress.

Corn

The year began with a cool wet spring, followed by an abnormally hot and dry summer. Severe plant stress was evident in corn from mid-August. Grain harvest began early, on 1 October. Grain moisture was below normal and stalk breakage above normal.

Breeding. Six new hybrids were supported for licensing: OX731 and OX724 in Ontario, OX610 in Atlantic Canada, OX730 and OX735 in Manitoba, and OX666 in Alberta. OX610 is a three-way hybrid and was the earliest hybrid in the Atlantic trials (11 site-years). OX731 and OX724 are three-way hybrids each requiring approximately 2500 corn heat units (CHU). OX730 and OX735 are three-way hybrids, earlier than the check hybrids in Manitoba, and with good kernel density and above-average stalk quality. OX666 is an early single cross with high yield in the Alberta performance trials.

Emphasis continued to be placed on the development of modified single-cross and three-way hybrids. Several early Manitoba populations (2100–2400 CHU) were evaluated for the Ottawa environment (2900 CHU) in 1983. These sources had good stalk quality, yield, and early maturity in combination with good spring vigor.

Improving stalk and root properties continued to be a major objective of the breeding program. Corn borer resistance appears to be a related property. A laboratory method of screening for tolerance for cool conditions is being investigated to enable preliminary screening of source material.

Soybeans

Breeding. In 1983 in Ontario, more hectares of the soybean cultivar Maple Arrow were field inspected for pedigreed status than of any other. This is the first time that a short-season variety has been produced on such a large scale. Line OT81-5 was supported for licensing by the Ontario Oil and Protein Seed Crops Committee. In short-season areas of Ontario and in the Maritime Provinces, OT81-5 yields 4–9% more than Maple Amber and is much more tolerant of the herbicide metribuzin. It also has a yellow hilum and a larger seed than Maple Amber, which increases its potential in the edible soybean export market. A new line of Evans maturity, OT83-4, was the top-yielding entry in the 1983 Ontario Soybean Variety trial, 2600 heat unit area.

Seed of the natto-type line OT82-2 was increased and sent to Japan for quality evaluation. This line is several days earlier in maturity than Nattawa and is less sensitive to the herbicide metribuzin. The yield of OT82-2 was disappointing in 1983 because of poor emergence and subsequent reduced stands.

The narrow leaflet (*ln*) backcross line of Maple Presto is now isogenic and will be made available from Plant Gene Resources of Canada for use as a genetic marker and for crop physiology experiments. Eight plants of Maple Amber, which carries the gene for metribuzin sensitivity, were identified in solution tanks to be tolerant of the herbicide. Seed of these plants is being increased to allow for progeny testing.

Out of 47 isolates of the bacterial blight pathogen (*Pseudomonas syringae* pv. *glycinea* Young, Dye & Wilkie) of soybean [*Glycine max* (L.) Merrill] collected from various counties of eastern Ontario, 42 proved to belong to race 4 as determined by using seven differential soybean cultivars (Acme, Chippewa, Flambeau, Harosoy, Lindarin, Merit, and Norchief). Four of the remaining five isolates appear to be close to race 5 or 10; the fifth one remains to be classified. A method for determining random or nonrandom distribution of soybean bacterial blight in growers' fields has been developed.

GENETIC ENGINEERING

Developmental plant physiology

Techniques for forage legume tissue culture were developed and improved, especially with commercial alfalfa (*Medicago sativa* L.) cultivars. Strong genotypic variation was observed with all in vitro procedures at both the varietal and individual plant level. The in vitro response of varieties with a high level of regeneration (via somatic embryo genesis) was correlated with the presence of two landrace breeding sources, Ladak and *M. falcata* L., in the responding varieties.

The efficiency of alfalfa shoot tip and nodal cultures was improved from 40% to close to 100% and in somatic embryo culture from 26% to 55% through modifications to the medium. The major gain was made by reducing levels of carbohydrate (3% → 1% sucrose) and growth regulators (2 mg/L → 0.02 mg/L).

The physiological conditions for establishing efficient protoplast cultures from several different alfalfa cell cultures were identified. A narrow sampling window of about 48 h during the time of rapid cell division and high respiratory activity in the 1-wk growth cycle was shown to be optimum for protoplast isolation and subsequent cell colony recovery.

Cell suspension cultures were initiated from epidermal tissues of *Brassica nigra* and from isolated microspores of *B. napus* L. cultivar Jet Neuf. Embryo formation was achieved when the auxin level was reduced and plants were regenerated at efficiencies of >25% through the induction of shoot buds in cultured embryos.

Experimental haploidy

More than 100 haploid plantlets were obtained in *B. napus* Westar, a cultivar that had been recalcitrant to standard anther culture procedures. Improved anther culture response (in up to 40% of the donor plants) was achieved by supplementation of the nutrition of donor plants with slow-release fertilizers and ammonium solutions.

Somatic cell genetics

Progress was achieved in the development of in vitro procedures for the isolation of chloroplast mutants. Toxicity studies with two inhibitors of chloroplast function demonstrated that alfalfa cells in suspension culture can detoxify kanamycin, making it inappropriate as a mutant selection agent, but that streptomycin inhibited cell growth for over 100 days. Studies with a large population of 10^9 cells over a 200-day period suggested that photosynthetic competence was a prerequisite for the selection of chloroplast mutants. Streptomycin reduced germination rate, bleached seedlings, and inhibited shoot and root growth in alfalfa, indicating that a seed germination test could be used as a rapid diagnostic assay for the mutant phenotype.

In studies on the isolation of nuclear mutants, alfalfa suspension cultures were shown to detoxify the protein synthesis inhibitor cycloheximide. The amino acid analogue DL-ethionine efficiently inhibited alfalfa suspension cultures at concentrations above 1.5 mM. Mutants were not recovered from a population of 8×10^8 cells monitored for 120 days, strongly indicating that this is a nuclear recessive trait, not easily recovered in a tetraploid species.

Potential somatic hybrid cell colonies were selected subsequent to fusion of protoplasts isolated from a cell culture of *Solanum sisymbriifolium* Lam. and from an azauracil-resistant line of eggplant (*S. melongena* L.). Cytological, morphological, and isozyme analysis of seven regenerated lines indicated that all plants evaluated were somatic hybrids.

Plant molecular genetics

To develop methods for transferring genes into crop plants, conditions for the regeneration of broccoli (*Brassica oleracea* L.) from crown gall (genetically transformed) tissue have been examined. A very sensitive fluorographic method for opine detection has been developed and used to identify transformed tissues. Several broccoli plantlets have been regenerated and those reaching maturity have been propagated by tissue culture. Alfalfa cells have been examined as hosts for artificial transformation. The synchronization of DNA synthesis, protein synthesis, mitosis, and cytokinesis was examined and demonstrated in regenerating protoplasts and compared with the asynchrony of these events in cell suspension cultures and regenerated protoplasts. The spectrum of proteins synthesized was characterized. In vitro methods for achieving DNA-mediated transformation of alfalfa protoplasts were developed. Several potential transformed colonies were selected, cell suspension cultures were initiated, and single-cell cloning in one line was achieved.

The microinjection of living protoplasts was achieved as a result of several developments. Nontoxic methods for selective fluorescent staining of nuclei and cytoplasm, for reversible attachment of protoplasts to glass surfaces, and for subsequent relocation of microinjected protoplasts by culture on photoengraved cover slips were developed. Equipment for controlling the environment around the protoplasts has been designed and constructed. Volumes of 10^{-15} L can now be positioned in specific cellular compartments. Intranuclear microinjection rates of 80 protoplasts per hour have been accomplished for alfalfa, *Brassica*, and rye protoplasts. Twenty-five experiments to inject plasmid DNA into alfalfa nuclei have been performed.

ORNAMENTALS

Floriculture

Maximum flower production of the New Guinea *Impatiens* cultivar Starburst at 20°C occurred in 12-h photoperiods. Decreased flowering in long photoperiods was due to inhibition of lateral branch growth. This was a photoperiodic effect. Plant height, node production, and flowering node were not affected by interruption of dark periods, but total flower production was significantly inhibited.

Improved micropropagation procedures for *Begonia* × *hiemalis* Fotsch. were developed. Auxin/cytokinin combinations that gave maximum induction of adventitious buds were not suitable for micropropagation because subsequent plantlet growth in vitro was limited. Lower auxin/cytokinin concentrations induced fewer buds but produced more large plantlets, which could be easily excised and successfully rooted. In vitro rooted explants developed weak root systems and acclimation losses occurred in the greenhouse. Adventitious shoots treated with rooting powder and placed directly in mist frames produced stronger root systems and adaptation losses were eliminated. The elimination of the in vitro rooting stage simplified the micropropagation program.

An in vitro bioassay was developed to monitor quantitative changes in the photoinduced state of leaves and leaf explants of *Streptocarpus nobilis* (C.B. Clarke). A quantitative relationship between photoinduction of donor plants (in vivo induction) and subsequent in vitro flowering had been established. During induction, flowering proceeded through initiation to seedpod development. Correlative influences of these processes were investigated. In vitro flowering was not affected by the postinductive flower development of donor plants, but various degrees of photoinduction of leaf tissue were expressed in vitro. Similarly, quantitative changes in the photoinduced state of leaf explants occurred in response to in vitro photoinduction. Thus, quantitative changes in the induced state of leaf tissue was demonstrated for both in vivo and in vitro photoinduction.

Changes in the proton relaxation rates of plant cell membranes, presumably caused by initiation of flowering in photoperiod-sensitive plants, that is, *Streptocarpus* and spinach, were investigated by nuclear magnetic resonance (NMR) techniques. Results indicated that the changes were caused by the photoperiod treatment independent of the flowering response.

The British spray chrysanthemum cultivars Yellow Snapper, Bronze Snapper, White Snapper, Pink Snapper, Pale Yellow Snapper, and Pale Salmon Snapper, reportedly tolerant of relatively low growing temperature, were tested during the fall season. The cultivars were comparable in appearance to the good spray-type cultivars originating in Canada or the USA.

Pathology

Pythium aphanidermatum (Edson) Fitzp. was isolated from chrysanthemum, poinsettia, geranium, impatiens, begonia, and salvia in greenhouses in Ontario and Quebec. Cross-inoculation of these hosts demonstrated that pathogenic differences existed among the isolates. *P. aphanidermatum* from impatiens, begonia, and salvia was significantly less pathogenic on chrysanthemum, poinsettia, and geranium than the isolates from poinsettia and geranium, whereas the isolate from chrysanthemum was pathogenic only on chrysanthemum cultivars.

When young carnation plants were planted in greenhouse benches in a soil–sand–peat mixture inoculated with *P. aphanidermatum*, *Rhizoctonia solani* Kühn, or both fungi simultaneously, cut-flower production was reduced significantly although neither fungus caused readily observable symptoms. Number of saleable cut flowers was reduced 15–19%

by infection with *R. solani*, 28–34% by *P. aphanidermatum*, and 19–24% by a combination of the two, when compared over a 6-mo period to healthy checks. When the growing medium was treated with a combination of Benlate and Truban, yield of the inoculated plants equaled that of the untreated, uninoculated checks.

Several fungi were isolated from roots and crowns of unthrifty *Ficus benjamina* L. (weeping fig) plants growing in interior landscapes, greenhouses, and private homes. *R. solani, P. aphanidermatum, Fusarium oxysporum* Schlecht., and *Cylindrocarpon* sp. were the fungi most frequently isolated. When young *Ficus benjamina* plants were grown in a soil–sand–peat mixture containing any one of these fungi, severe root rot developed. However, only *R. solani* and *Fusarium oxysporum* were capable of infecting older established plants.

Plant breeding

A new winter-hardy climbing rose, William Baffin, was registered. William Baffin combines hardiness with free and repeated flowering, and resistance to mildew, *Sphaerotheca pannosa* (Wallr. ex. Fr.) Lév., and blackspot, *Diplocarpon rosae* Wolf. It is one of the few winter-hardy climbers that survives the winters in Ottawa with tip-killing only, and thus can be left on the trellis over winter.

A study of fertility and incompatibility was carried out with three sister seedlings of *Rosa rugosa* Thunb. These seedlings were crossed in each of the nine combinations. One seedling was self-incompatible and one of the two self-compatible seedlings produced fewer ovaries per hip. The criterion for compatibility was the percentage of ovaries that developed into achenes. The self-incompatible seedling produced approximately twice as many achenes when used as a pollen parent than it did in the reciprocal cross.

Several *Weigela* selections with a prolonged flowering period and low stature, and with purple foliage and low stature, are being further evaluated. *Forsythia* selections with hardy flowerbuds were obtained, but, so far, only one of these has a low plant habit.

Nursery research

Mycorrhizal association of *Euonymus fortunei* (Turcz.) Hand.-Mazz. cultivar Emerald Gaiety with *Glomus* fungi was shown to improve the level of drought tolerance due to avoidance of severe water stress. Under conditions without stress, transpiration rate, diffusive resistance of leaves to water vapor loss, and leaf water potential and components were similar. However, under drought stress, plants in mycorrhizal association had significantly lower leaf transpiration rates, higher leaf resistance to water loss, and better tissue water status. After recovery from drought, significantly less leaf damage was noted in the mycorrhizal plants. Dry matter production and therefore water use efficiency were also increased by mycorrhizal infection.

It was demonstrated that inoculation of the rooting medium prior to rooting was an effective means of infecting softwood cuttings with *Glomus* mycorrhizal fungi. In some species (15 woody ornamentals were evaluated), initial root development was delayed; however, mycorrhizal fungi stimulated both root and shoot growth by the end of the first growth period after rooting.

Infection of rooted cuttings of *Euonymus fortunei* cultivar Coloratus with *Glomus* mycorrhizal fungi delayed fall color development to the same extent as P fertilization. However, unlike P fertilization, this infection increased the effective length of the growing season without any increased susceptibility to winterkilling.

Ornamental garden

One hundred and seventy-one cultivars of *Petunia* were evaluated during the summer of 1983. The top-scoring cultivars were, among multiflora singles, Gypsy, Snowdrift, and Moonglow; multiflora doubles, Raspberry Tart, Peppermint Tart, and Blueberry Tart; grandiflora singles, Happiness, Sugar Daddy, Glacier, Pink, and Paradise; and grandiflora doubles, Superstar Red and White, Think Pink, and Valentine. In miscellaneous trials the outstanding annuals were *Coleus* Seven Dwarfs Mix, *Thymophylla tenuifolia* (Dahlberg daisy), and a red-leaved *Hibiscus*, Rotblattrig.

PLANT GENE RESOURCES

Plant gene information

Descriptions for a total of 5083 stocks of barley, oats, tomatoes, and wheat were entered in their respective crop information banks in 1983. They represent about 40% of the stocks included in the Canadian Crop Genetic Resources Inventories (12 673 stocks) held at present at the Plant Gene Resources of Canada (PGRC) office. Included in 1983 were 906 accessions from a 1980 Ethiopian barley collection that were evaluated for BYDV resistance, and 3185 accessions from the Regina wheat collection transferred to the PGRC office a few years ago. The information on each stock is stored in the respective crop data banks, and computer-generated trait inventories on each crop are available.

Conservation

Close to 76 000 seed stocks of various plant species are being preserved under controlled conditions at the PGRC office. The seed facilities include 54 m^3 at 4°C and 20% relative humidity for medium-term storage, and 145 m^3 at −20°C, using airtight containers, for long-term storage. Over 15 500 genetic stocks, cultivars, breeding lines, and other material of various crops and related species have been obtained by the PGRC office since 1972 as a result of its activities in the field of national and international exchanges of plant material. Almost 3000 stocks were added to this collection (PGR Collection) in 1983. In addition, the PGRC office obtained a duplicate of the University of Manitoba Rye Collection (1071 accessions) and of the Kenyan Wheat Stem Rust Parental Collection (410 accessions). Additional material received in 1983, as a result of Canada's participation in the program of the International Board for Plant Genetic Resources for the preservation of international collections of valuable germ plasm, included collections of pearl millet, oats, barley, rapeseed, and mustard from Burundi, Kenya, Mali, Pakistan, Syria, Upper Volta, Zambia, and Zimbabwe. A total of 3065 accessions from these collections are preserved in the seed stores.

Exchanges

In 1983, activities in connection with exchanges of genetic stocks and cultivars involved 388 exchanges with individuals in 35 countries, for a total of 9400 accessions.

Newsletter

The PGRC Newsletter, which was started in 1976, has a mailing list of 779 individuals, 571 in Canada and 208 in 38 other countries. The semiannual newsletter reports informally on activities in Canada and elsewhere, in connection with plant gene resources.

EXPERIMENTAL FARM KAPUSKASING, ONT.

Forage management

Timothy seed production trials were sown in 1979 and 1980 in collaboration with scientists from the Sainte-Foy Research Station to examine several aspects of management. Test plots were sown either in the spring or fall after a cereal harvest, with or without a cover crop of barley, at three seeding rates: 3.0, 4.5, and 9.0 kg/ha; and five spacings: broadcast, and with 18, 36, 54, and 72 cm between rows.

When timothy was sown after a cereal harvest in September, for each of the 2 yr it was not possible to obtain establishment.

In both the 1979 and 1980 spring seedings, timothy established without a cover crop resulted in a significantly higher yield of seed from 1980 to 1983. In the 1979 test, the average yield of seed was 318 kg/ha when sown with a cover crop and 418 kg/ha when sown in a pure stand. Similar results were obtained in the 1980 seeding with even larger differences; seeding with a cover crop produced an average seed yield of 223 kg/ha, and 444 kg/ha without a cover crop.

With good seedbed preparation, seeding at a rate higher than 3 kg/ha is not necessary as it resulted in the establishment of a good stand. The average seed yield over the years was 348, 359, and 346 kg/ha for the rates of 3.0, 4.5, and 9.0 kg/ha, respectively.

When the various seeding methods and row spacings were examined, it was found that a row spacing of 18 cm produced the most timothy seed per hectare followed by the broadcast seeding. In other row spacings, the yields dropped with increasing width between rows. The average seed yields from the two seeding years were 403 kg/ha for rows spaced at 18 cm, 393 kg/ha for a broadcast seeding, 370 kg/ha for rows spaced at 36 cm, 320 kg/ha for rows at 54 cm, and 270 kg/ha for rows at 72 cm.

Cereal management

Spring wheat variety trials have been conducted with the Conseil des productions végétales du Québec for many years with excellent yields under plot conditions.

Currently in Ontario only one spring wheat variety, Glenlea, is recommended. Over the years, at least 11 varieties of spring wheat from Quebec and the Maritimes have been tested in regional trials. The consistently highest-yielding variety has been Casavant with a 4-yr average yield of 5937 kg/ha, followed by Milton and Mondor with grain yields of 5599 and 5552 kg/ha, respectively. Glenlea was 9th out of 11 varieties, with a yield of 4788 kg/ha (7 yr of data). All of the new cultivars require 6–8 days more than Glenlea to reach maturity.

EXPERIMENTAL FARM THUNDER BAY, ONT.

Potato management

On 12 May 1983, potato tubers of 15 varieties and breeders' lines were seeded for the purpose of tuber sizing and total yield. At seeding, 1120 kg of 17-17-17 fertilizer was banded with the seed. On 7 June, Linuron (DuPont) was applied at 1 kg/ha for weed control. On 11 July Sevin (Union Carbide) and Manzate (DuPont) were applied at equal rates of 2.24 kg/ha for the control of Colorado potato beetle and potato blight.

Harvesting took place on 2, 12, and 22 August with final harvesting on 20 September 1983. Temperatures generally throughout the growing season were higher than normal (+3°C for June and July and +4°C for August). Precipitation during May, June, and July was –40 mm, with +20 mm of precipitation for August. While no significant differences in yield were noted for the first two harvest dates, a considerable increase in yields was noted for 22 August and final harvest on 12 September, but total yields were below average for this area.

The variety Yukon Gold ranked second, behind the experimental line F72-217, when harvested on 12 and 22 August, but fell to 10th place on final harvest. Final ranking for F72-217 was third, at 25 519 kg/ha of marketable potatoes. The variety Shepody ranked second in final harvest with a marketable yield of 26 943 kg/ha. The breeder line G735-7P ranked fourth with a marketable yield of 25 356 kg/ha. The top-yielding variety was Norchip with a marketable yield of 27 025 kg/ha. The differences in yield between the top four varieties in 1983 was 1669 kg/ha.

PUBLICATIONS

Research

Armstrong, K. C. 1983. The relationship between some Eurasian and American species of *Bromus* section *Pnigma* as determined by the karyotypes of some F_1 hybrids. Can. J. Bot. 61:700-707.

Armstrong, K. C.; Keller, W. A. 1982. Chromosome pairing in haploids of *Brassica oleracea*. Can. J. Genet. Cytol. 24:735-739.

Armstrong, K. C.; Nakamura, C.; Keller, W. A. 1983. Karyotype instability in tissue culture regenerants of triticale (×*Triticosecale* Wittmack) cv. 'Welsh' from 6-month-old callus cultures. Z. Pflanzenzuechtg. 91:233-245.

Bolton, A. T. 1983. Variability in pathogenicity on poinsettia of *Rhizoctonia solani* isolated from various hosts. Can. J. Plant Pathol. 5:181-184.

Brach, E. J.; Simmonds, J.; Poirier, P. 1983. Wavelength programmable spectrophotometer for individual plant studies. Soc. Phot-Opt. Inst. Eng. 380:70-76.

Clark, R. V. 1983. Leaf blotch in oats in relation to level of manganese nutrition and uptake. Can. J. Plant Pathol. 5:89-96.

Douglas, G. C.; Wetter, L. R.; Keller, W. A.; Setterfield, G. 1983. Production of sexual hybrids of *Nicotiana rustica* × *N. tabacum* and *N. rustica* × *N. glutinosa* via in vitro culture of fertilized ovules. Z. Pflanzenzuecht. 90:116-129.

Earp, C. F.; Doherty, C. A.; Fulcher, R. G.; Rooney, L. 1983. β-glucans in the caryopsis of *Sorghum bicolor* (L.) Moench. Food Microstruct. 2:174-181.

Faris, M. A.; Burity, H. A.; Dos Reis, O. V.; Mafra, R. C. 1983. Intercropping of sorghum or maize with cowpeas or common beans under two fertility regimes in northeastern Brazil. Exp. Agric. 16:251-261.

Faris, M. A.; Sabo, F. E.; Barr, D. J. S. 1983. Studies on *Phytophthora megasperma* isolates with different levels of virulence on alfalfa cultivars. Can. J. Plant Pathol. 5:29-33.

Fedak, G. 1983. Hybrids between *Hordeum parodii* and *Hordeum vulgare*. Can. J. Genet. Cytol. 25:101-103.

Fedak, G. 1983. Haploids in *Triticum ventricosum* induced by *Hordeum bulbosum*. Can. J. Genet. Cytol. 25:104-106.

Fejer, S. O.; Fedak, G. 1983. Effect of size and protein content of barley kernels on plant growth and development. Cereal Res. Commun. 11:37-41.

Frégeau, J. A.; Wightman, F. 1983. Natural occurrence and biosynthesis of auxins in chloroplast and mitochondrial fractions from sunflower leaves. Plant Sci. Lett. 32:23-24.

Gleddie, S.; Keller, W. A.; Setterfield, G. 1983. Somatic embryogenesis and plant regeneration from leaf explants and cell suspensions of *Solanum melongena* L. (eggplant). Can. J. Bot. 61:656-666.

Gleddie, S.; Keller, W. A.; Setterfield, G.; Wetter, L. R. 1983. Somatic hybridization between *Nicotiana rustica* and *N. sylvestris*. Plant Cell Tissue and Organ Culture 2:266-283.

Harcourt, D. G. 1982. Pest management. IDIA 397:27-43 (In Spanish).

Harcourt, D. G. 1983. A sequential decision plan for management of the alfalfa blotch leafminer, *Agromyza frontella* (Diptera: Agromyzidae). Can. Entomol. 115:1513-1518.

Harcourt, D. G.; Binns, M. R.; Guppy, J. C. 1983. Sample size determination for *Hypera postica* (Coleoptera: Curculionidae) adults: A comparison of two methods. Environ. Entomol. 12:1623-1627.

Harcourt, D. G.; Yee, J. M.; Guppy, J. C. 1983. Two models for predicting the seasonal occurrence of *Agromyza frontella* (Diptera: Agromyzidae) in eastern Ontario. Environ. Entomol. 12:1455-1458.

Keller, W. A.; Armstrong, K. C. 1983. Production of haploids via anther culture in *Brassica oleracea* var. *italica*. Euphytica 32:151-159.

Klimaszewska, K.; Keller, W. A. 1983. The production of haploids from *Brassica hirta* Moench (*Sinapis alba* L.) anther cultures. Z. Pflanzenphysiol. 109:235-241.

Orr, W.; de la Roche, A. I.; Singh, J.; Voldeng, H. 1983. Imbibitional chilling injury in cultivars of soybeans differing in temperature sensitivity to pod formation and maturation periods. Can. J. Bot. 61:2996-2998.

Sampson, D. R.; Flynn, D. W.; Jui, P. Y. 1983. Inheritance of kernel protein content in five spring wheat crosses. Can. J. Genet. Cytol. 25:398-402.

Sampson, D. R.; Flynn, D. W.; Jui, P. Y. 1983. Genetic studies on kernel hardness in wheat using grinding time and near infrared reflectance spectroscopy. Can. J. Plant Sci. 63:825-832.

Seaman, W. L.; Schneider, E. F. 1983. Snow mold damage to winter wheat in Ontario. Can. J. Plant Pathol. 5:211.

Simmonds, J. 1983. 'Northern Sunset' impatiens. Can. J. Plant Sci. 63:767-768.

Simmonds, J. 1983. Direct rooting of micropagated M26 apple rootstocks. Sci. Hortic. 21:233-241.

Svejda, F. 1983. 'William Baffin' rose. HortScience 18(6):962.

Wood, P. J; Fulcher, R. G.; Stone, B. A. 1983. Studies on the specificity of interaction of cereal cell wall components with congo red and calcofluor. Specific detection of histochemistry of (1→3), (1→4)-β-D-glucan. J. Cereal Sci. 1:95-110.

Wood, P. J.; Fulcher, R. G. 1983. Dye interactions. A basis for specific detection and histochemistry of polysaccharides. J. Histochem. Cytochem. 31:823-826.

Yiu, S. H.; Altosaar, I.; Fulcher, R. G. 1983. The effects of commercial processing on the structure and microchemical organization of rapeseed. Food Microstruct. 2:165-173.

Miscellaneous

Atanassov, A. I.; Brown, D. C. W. 1983. Plant regeneration from suspension culture and mesophyll protoplasts of alfalfa. Experientia Supp. 45:40-41.

Basu, P. K. 1983. Survey of eastern Ontario alfalfa fields to determine common fungal diseases and predominant soil-borne species of *Pythium* and *Fusarium*. Can. Plant Dis. Surv. 63:51-54.

Brown, D. C. W.; Koehl, E. M. 1983. Regeneration of alfalfa from protoplast cell and callus cultures. In Vitro 19(3)II:249-250.

Burity, H. A.; Faris, M. A.; Coulman, B. 1983. Specific nodule activity of alfalfa grown alone and in mixture with grass under greenhouse conditions. Proc. 5th Eastern Forage Improvement Conf., Macdonald Campus of McGill Univ., Ste. Anne de Bellevue, Que.

Burrows, V. 1983. Cereal improvement: A challenge to breeders and food scientists. J. Can. Diet. Assoc. 44(3):7.

Cole, T. J. 1983. Woody plant source list. Agric. Can. Res. Branch. 83 pp.

Cole, T. J. 1983. Canadian specialist plant societies. Agric. Can. Res. Branch. 16 pp.

Cole, T. J. 1983. Coleus trials 1982. Canadex 281.34.

Cole, T. J. 1983. Portulaca, verbena and cosmos trials. Canadex 281.34.

Cole, T. J. 1983. Wax begonia trials—1981. Canadex 281.34.

Cole, T. J. 1983. Zinnia trials—1981. Canadex 281.34.

Cole, T. J. 1983. Marigold trials—1982. Canadex 281.34.

Cole, T. J. 1983. Perennials in your garden/Les fleurs vivaces de votre jardin. Agric. Can. Publ. 1754.

Dhesi, N. S.; Fedak, G.; Desormeaux, R. W. 1983. Effect of agroclimatic factors and seed age in the development of various enzymes in barley. Assoc. Offic. Seed Anal. 57:17-21.

Douglas, G. C.; Keller, W. A.; Setterfield, G. 1983. Overcoming genetic incompatibility in hybridization of *Nicotiana tabacum* with *Nicotiana rustica*. Pages 16-28 *in* Cassells, A. E., Kavanagh, J. A., eds. Plant tissue culture in relation to biotechnology. Royal Irish Academy, Dublin.

Faris, M. A. 1983. Variability and interaction between alfalfa cultivars and *Phytophthora megasperma* isolates. Proc. 5th Eastern Forage Improvement Conf., Macdonald Campus of McGill Univ., Ste. Anne de Bellevue, Que.

Faris, M. A. 1983. Progress report on a creeping alfalfa trial at the Ottawa Research Station. Forage Notes 27:67-70.

Faris, W. A. 1983. Variation in the rate of nitrogen fixation among red clover cultivars. Forage Notes 27:77-80.

Faris, M. A.; Atwal, A. S. 1983. Effects of cutting schedules on yield, forage quality and stand vigor of alfalfa (*Medicago sativa* L.). Forage Notes 27:71-76.

Fulcher, R. G.; Wood, P. J.; Yiu, S. H. 1983. Identification of cereal carbohydrates by fluorescence microscopy. Chapter IV, Pages 111-148 *in* Bechtel, D. B., ed. New frontiers in food microstructure. Am. Assoc. Cereal Chemists, St. Paul, MN.

Gleddie, S. C.; Keller, W. A.; Setterfield, G. 1983. Somatic embryogenesis and plant regeneration from protoplasts of eggplant (*Solanum melongena* L.). Experientia Supp. 45:66-67.

Gochnauer, T. A. 1983. An historical review of the occurrence, diagnosis and treatment of European foulbrood disease in Minnesota. Pages 13-27 *in* Proc. Int. Symp. European Foulbrood. Government of Quebec. 132 pp.

Haeselbarth, E.; Loan C. 1982. *Townesilitus*, a new genus for a species group in *Microctonus* (Hymenoptera: Braconidae, Euphorini). Am. Entomol. Inst. 20:384-387.

Harcourt, D. G. 1982. A sequential sampling scheme for the alfalfa blotch leafminer. Proc. 19th N.E. Alfalfa Insects Conf., Ohio State Univ., Wooster.

Harcourt, D. G. 1983. Early warning system for alfalfa blotch leafminer in Ontario. Canadex 622.121.

Loan, C. 1982. Host and generic relations of the Euphorini (Hymenoptera: Braconidae). Am. Entomol. Inst. 20:388-397.

Reinbergs, E.; McLaughlin, R.; Burrows, V.; Lockington, S. M. 1983. Oats for milling. Agdex 113.82.

Simmonds, J. 1983. *Impatiens* Northern Sunset. Canadex 281.33.

Svejda, F. 1983. Champlain rose. Canadex 283.33.

Svejda, F. 1983. Charles Albanel rose. Canadex 283.33.

Yee, J. M.; Harcourt, D. G. 1983. SIMWEEVIL/SIMABL. An IPM monitoring system for alfalfa weevil and alfalfa blotch leafminer. Agric. Can. Res. Branch Publ. 1983-5E. 33 pp.

Research Station
Vineland Station, Ontario

PROFESSIONAL STAFF

D. R. Menzies, B.S.A., M.Sc., Ph.D.	Director
E. Piil	Administrative Officer
M.-J. Boisvenue,[1] B.Sc., M.Bibl.	Librarian

Entomology

A. B. Stevenson, B.Sc. (Agr.), Ph.D.	Head of Section; Vegetable pest management
A. B. Broadbent, B.Sc., M.Sc., Ph.D.	Ornamental entomology
E. A. C. Hagley, B.Sc. (Agr.), M.Sc., Ph.D.	Fruit pest management
D. J. Pree, B.S.A., M.Sc., Ph.D.	Toxicology
H. M. A. Thistlewood,[2] B.Sc., M.Sc.	Acarology
R. J. M. Trimble, B.Sc., M.Sc., Ph.D.	Bioclimatology

Nematology, Chemistry, and Computer Science

J. W. Potter, B.S.A., M.S.A., Ph.D.	Head of Section; Nematode ecology and chemical control
M. Chiba, B.Sc., D.Sc., F.C.I.C.	Residue chemistry
B. McGarvey, B.Sc., M.Sc.	Chemistry
T. H. A. Olthof, Ing., B.Sc. (Agr.), Ph.D.	Host–parasite relations
J. L. Townshend, B.Sc., M.Sc., D.I.C.	Nematode ecology
J. Yee,[3] B.Sc., M.Sc., Ph.D.	Mathematics and computing

Plant Pathology

W. R. Allen, B.A., Ph.D.	Head of Section; Fruit and soil-borne viruses
A. R. Biggs,[4] B.Sc., M.Sc., Ph.D.	Tree fruit diseases
R. F. Cerkauskas,[5] B.Sc., M.Sc., Ph.D.	Vegetable diseases
J. A. Matteoni,[6] B.Sc., M.Sc., Ph.D.	Ornamental pathology
J. Northover, B.Sc., Ph.D., D.I.C.	Fruit mycology
A. A. Reyes, B.S.A., M.S.A., Ph.D.	Vegetable mycology

L. W. Stobbs, B.Sc., M.Sc., Ph.D.	Grapevine viruses

Smithfield Experimental Farm, Trenton, Ont.

S. R. Miller, B.Sc., M.Sc., Ph.D.	Superintendent; Pomology
W. P. Mohr, B.S.A., M.S.A., Ph.D.	Food processing
J. G. Metcalf	Tomato breeding
N. J. Smits, B.Sc.	Vegetable management
J. Warner, B.Sc., M.Sc.	Pomology

Departure

D. H. C. Herne, B.A., M.S.A., Ph.D. Retired May 1983	Acarology

EXTENSION SERVICES[7]

D. Ridgway	Fruit and vegetable crops

---

[1] Seconded from Libraries Division, Finance and Administration Branch.
[2] Appointed 24 November 1983; on educational leave.
[3] Appointed 4 January 1983.
[4] Appointed 4 January 1983.
[5] Appointed 6 January 1983.
[6] Appointed 4 January 1983.
[7] Ontario Ministry of Agriculture and Food, Trenton, Ont.

INTRODUCTION

The Vineland Research Station serves the horticultural industry with a comprehensive program of crop protection research. The multidisciplinary, goal-oriented program applies knowledge of entomology, toxicology, acarology, nematology, virology, mycology, computing science, and residue chemistry to the pest and disease problems of a diversity of horticultural crops. The Smithfield Experimental Farm, located near Trenton, is administratively linked to this Station and carries on horticultural production and processing research, as well as pest control research programs in collaboration with Vineland.

A number of changes have occurred in the professional staff at Vineland this year. Dr. D. H. C. Herne retired after 31 years of service, and Dr. A. R. Biggs, Dr. R. F. Cerkauskas, Dr. J. A. Matteoni, Mr. H. Thistlewood, and Dr. J. Yee joined the research staff.

This report summarizes some of the research results from the Station in 1983; more detailed information can be obtained from the publications listed at the end of the report. For more information on these or other research projects, or for copies of this report, please write to the Director, Research Station, Research Branch, Agriculture Canada, Vineland Station, Ont. L0R 2E0.

D. R. Menzies
Director

TREE FRUITS

Insects and mites

Biological control. Mass releases of the goldeneye lacewing, *Chrysopa oculata* Say, reduced the numbers of the European red mite (ERM), *Panonychus ulmi* (Koch), on dwarf Red Delicious apple trees and those of the apple aphid, *Aphis pomi* De Geer, on semidwarf trees. Initial releases of an insecticide-resistant strain of *Chrysopa carnea* Stephens indicated that this species also has considerable potential as a biological control agent against aphids and mites on apple. Both species were readily mass-produced on a diet of aphids, mites, coddled lep larvae, and an artificial diet mix.

Releases of adult *Pholetesor (Apanteles) ornigis* Weed, the major parasite of the spotted tentiform leafminer (STLM), *Phyllonorycter blancardella* (Fabricius), resulted in 3- to 13-fold increases in parasitism in the first STLM generation. Releases were made following the application of low rates of permethrin at the prebloom stage to reduce the leafminer population. The occurrence and activity of *P. ornigis* were also closely synchronized with the most susceptible stages of its host. Further development and improvement of mass-rearing techniques should facilitate utilization of this parasite for biological control of STLM.

Chemical control. Simulated rainfalls of 11–17 mm accelerated losses of phosmet residues for up to 6 days following spray applications. At low application rates, with active ingredient (a.i.) at 0.6 kg/ha, significant reductions in mortality of larvae of the oriental fruit moth (OFM), *Grapholita molesta* (Busck), occurred when water was applied during the first 3 days after application. Effects of residue losses were delayed; significant reductions in mortality of larvae did not occur until 3–6 days after the simulated rains. Although simulated rain also removed phosmet from higher deposits, effects on mortality of larvae were not significant. Application of phosmet at an a.i. rate of 1.1 kg/ha, which provided control of OFM larvae for 7–10 days and did not require respraying when exposed to simulated rains, was judged optimal.

STLM from the Simcoe area were found to have developed low levels of resistance to the synthetic pyrethroid insecticides permethrin and fenvalerate. Cross resistance to other experimental pyrethroids and to DDT was also shown. Resistant populations were detected in 19 orchards in the Simcoe area, one in Wentworth County, and three in the Bowmanville–Trenton area. Populations from all areas retained high levels of resistance to organophosphate (OP) insecticides. Parasites remained susceptible to both OP and pyrethroid insecticides. These findings suggest that a shift from pyrethroid insecticides to carbamates such as methomyl is necessary in orchards where resistance has been detected.

Deltamethrin was compared to the standard phosmet program in a model integrated pest management (IPM) program for control of OFM on peach. At the rates suggested by the developer (with a.i. at 15 g/ha), deltamethrin was less effective (unacceptable) than phosmet. In addition, populations of mites (both the twospotted spider mite, *Tetranychus urticae* Koch, and ERM) were extremely high on deltamethrin-sprayed plots. These data imply that rates suggested are too low for control of OFM and exacerbate problems with mites.

The susceptibility of field-collected pear psylla, *Psylla pyricola* Foerster, from three Niagara orchards to OP, pyrethroid, and chlorinated hydrocarbon insecticides was assessed. Resistance to OP insecticides was detected at all three locations; suspected resistance to endosulfan was observed at one location. All populations were susceptible to the pyrethroid permethrin. Continued monitoring for the development of pyrethroid resistance is necessary so as to choose correctly pesticides effective against *P. pyricola*.

Ecology. Monitoring adult activity of the STLM using pheromone-baited traps provides some of the information used in the management of this important pest. However, meaningful interpretation of trap catches can be made only if two relationships are understood: first, the relationship between trap catches and male and female emergence; and second, the temporal relationship between male and female emergence. Observations in four orchards near Simcoe, Ont., during the spring emergence period and in three orchards in each of the two summer emergence periods indicated that male and female emergence is highly synchronized, with males being the first to emerge in some orchards. Therefore, the presence of males in pheromone traps indicates that females are also emerging and present in the orchard. In all orchards studied during each of the three emergence periods, pheromone trap catches of males were found to vary considerably during periods when the rate of moth emergence was constant. This indicates that pheromone trap catches of STLM cannot be used as an index of the rate of moth emergence. The size of pheromone trap catches is more likely to be a reflection of moth activity and could be expected to be influenced by air temperature, wind velocity, and precipitation.

Nematodes

In a 3-yr study of the transmission of peach rosette mosaic virus (PRMV) by nematodes, *Longidorus diadecturus* was found to be a stronger vector of the virus than *Xiphinema americanum*. When nematodes collected in the vicinity of a PRMV-infected peach were used to inoculate cucumber bait plants, up to 35% of the *L. diadecturus* were calculated to have transmitted the virus to the bait plants, and up to 20% of *X. americanum* were calculated to have been vectors. Both species are now considered epidemiologically important vectors in Ontario.

Diseases

Apple scab, Venturia inaequalis. Apple scab was found to be resistant to benomyl in 36 orchards, resistant to dodine in eight orchards, and resistant to both fungicides in a further five orchards. Benomyl is now known to be ineffective in 14 stone-fruit orchards in the Niagara Peninsula. The incidence of fungicide resistance in 1983 was more than double the number of known locations of resistance in 1982. This phenomenon, coupled with the expected problems of resistance to most of the new fungicide groups, has increased the reliance of the fruit industry upon dependable broad-spectrum fungicides such as Captan.

Peach canker, Leucostoma persoonii. Experiments were conducted to characterize histochemically the processes associated with healing of mechanical wounds and *L. persoonii* infections in peach tree bark. Histological examination revealed that host responses to wounding and pathogen colonization were basically similar, differing only in the timing and extent of the responses examined. Host responses were nonspecific and included gum production, changes in cell wall polysaccharides, cell wall lignification, and formation of suberized impervious tissues prior to wound periderm formation. The presence of the fungus was associated with inhibited differentiation of living tissues and, as a result, host processes responsible for impervious tissue and wound periderm formation were affected adversely.

GRAPES AND SMALL FRUITS

Insects

Grape berry moth (GBM), Paralobesia viteana (Clemens). The following recommended materials were evaluated for control of second-generation GBM under field conditions: parathion, azinphosmethyl, carbaryl, permethrin, phosalone, and diazinon. Parathion gave the best control, followed by azinphosmethyl, carbaryl, and permethrin; phosalone and diazinon were the least effective. The following synthetic pyrethroids were evaluated for control of second-generation GBM under field conditions: Orthene, FCR 1272, Belmark, and Decis. Orthene-treated vines had significantly fewer bunches damaged than control vines; there was no significant difference between those vines treated with FCR 1272, Belmark, and Decis, and the control vines.

Diseases

Grape bunch modification for disease control. In 1982 and 1983, gibberellic acid (GA_3) applied at an a.i. rate of 30 g/ha to Seyval grapes at prebloom, when clusters were 6 cm long, increased bunch length 2–3 cm and reduced berry tightness and the severity of bunch rot caused by the fungus *Botrytis cinerea*. Johannesburg Riesling also responded well to GA_3, but Chardonnay and Pinot Noir were insensitive to GA_3 at a.i. of 120 g/ha. For some cultivars with tight bunches prone to sour rot (breakdown) and bunch rot, the use of GA_3 could reduce the reliance upon fungicides to which *B. cinerea* may develop resistance.

Fruit diseases resistant to fungicides. Isolates of *B. cinerea* with low resistance (10-fold) to iprodione were identified in five vineyards in Niagara where this fungicide had been used 12–18 times over several years. Despite this, *Botrytis* bunch rot was well controlled by iprodione. Use of a combination of Captan with iprodione slowed the increase of iprodione resistance, compared with programs using iprodione alone. Benomyl-resistant *B. cinerea* was identified in each (100%) of 11 vineyards, and in 22 (46%) of 48 randomly sampled strawberry fields; benomyl would be ineffective in these locations.

Tomato ringspot virus (TomRSV). The influence of grapevine understock on the resistance of scion varieties to TomRSV has been examined. DeChaunac grafted onto resistant understock and planted in an established vineyard with a history of TomRSV infections has been monitored over a 6-yr period for evidence of scion infection. These grafted vines are being compared with self-rooted susceptible DeChaunac in either fumigated or fallow-land plots. Our findings indicate that resistant understock confers field resistance to DeChaunac and does not result in significant reductions in yield or crop quality. Of particular interest, DeChaunac controls grafted onto DeChaunac understock remained free from TomRSV over the 6 yr, whereas self-rooted DeChaunac became infected early in the study. It would appear that the graft union plays an important role in limiting virus movement to the scion wood.

VEGETABLES

Insects

Carrot rust fly (CRF), Psila rosae (Fabricius). Carbofuran (Furadan 10G) applied in the seed furrow is no longer an effective method of controlling CRF in the Holland Marsh and as a result, the recommendation for use of this method was withdrawn in Ontario.

In a trial conducted on 0.007-ha plots of carrots, in which four sprays were applied at 7-day intervals, the pyrethroid insecticides cypermethrin (Ripcord 40E) and deltamethrin (Decis 2.5E), at a.i. of 70 and 15 g/ha, respectively, significantly reduced injury by second-generation CRF. Phosmet (Imidan 50W) at 1.1 kg/ha was less effective. Diazinon, currently the most generally used material, did not provide any reduction of CRF injury.

Aster leafhopper (ALH), Macrosteles fascifrons (Stål). In laboratory toxicity trials, the pyrethroid insecticides deltamethrin, permethrin, cypermethrin, and fenvalerate were 67, 20, 13, and 3 times as toxic to ALH as carbaryl. Carbaryl was the most toxic of the insecticides currently recommended for control of this insect on carrots and lettuce. In a field trial, permethrin applied at 0.1 times the rate of carbaryl reduced the incidence of aster yellows, which is spread by ALH, by 94%, whereas carbaryl provided only 46% control.

Results of several years of monitoring ALH on vegetable crops grown on muck soil suggest that a management program for this insect could be of value in vegetable production in

Ontario. In most years, ALH were first detected on early lettuce about mid-May, and were present in varying numbers on carrots, lettuce, and celery until the end of the growing season. In 1983, by contrast, adults did not appear on vegetable crops until near mid-June, coinciding with maturation of adults from overwintered eggs on winter grain. Thus, the number of sprays applied to early lettuce could have been reduced by two to four based on these data. A second influx of adults into crops on muck soil in mid-July coincided with the maturation of adults on spring grain. A severe outbreak of aster yellows in the Holland Marsh in 1983 indicated that either the insecticides recommended for control are inadequate or the timing of sprays needs to be improved. A monitoring program for ALH would help to improve the latter aspect of the control program.

Nematodes

Host–parasite relationships. Pratylenchus penetrans, at an initial density of 1850 nematodes per kilogram of soil, reduced the yield of marketable tubers of the potato cultivar Russet Burbank by 15.7%. Total and marketable yields of tubers of five other cultivars, Kennebec, Monona, Norchip, Superior, and Yukon Gold, grown in Fox loamy sand infested with *P. penetrans* at 1600–2050/kg, did not differ significantly from those grown in nematode-free soil. Yukon Gold, Superior, and Monona harvested after 118 days contained, respectively, 4850, 5950, and 6100/kg soil at harvest and 11 350, 10 950, and 9200 per root system. Final densities in the soil and roots of Norchip, Kennebec, and Russet Burbank, harvested 3 wk later, were respectively 6600, 8450, and 9400/kg soil and 1800, 3500, and 5000 per root system.

Chemical control. The combination of Vorlex at 55 L/ha and Temik 10G at 22 kg/ha reduced the initial population density of *P. penetrans* to 100/kg soil, from 18 320/kg in the untreated control. Vorlex alone and Telone IIB at 75 L/ha reduced the initial populations to 350 and 260/kg soil, respectively. Temik alone, Vydate L at 18 or 9 L/ha, and Furadan 10G at 33 kg/ha applied at planting, resulted respectively in nematode densities of 2600, 1820, 4000, and 5820/kg at midseason. At harvest, soil treated with the combination of Vorlex and Temik contained significantly fewer nematodes (720/kg) than all others. Soils treated with Telone IIB, Temik, and Vorlex held, respectively, 5540, 6960, and 10 540/kg soil. Final densities in soils treated with the remaining compounds did not differ from the untreated control. Marketable yield of potatoes, cultivar Russet Burbank, grown with Vorlex plus Temik was 20.7 t/ha, compared with 4.7 t/ha for the untreated control. Vorlex and Telone IIB followed closely, with 17.3 and 15.9 t/ha, respectively, yet the difference from the combination treatment was significant. Temik treatment only yielded 7.5 t/ha and Vydate L at 18 and 9 L/ha and Furadan did not differ from the untreated control with, respectively, 6.9, 6.4, and 5.9 t/ha.

Diseases

Cucumbers. Anthracnose of cucumbers caused by *Colletotrichum orbiculare* is one of the most destructive diseases of cucumbers. The effect on Peppi and Triple Mech cultivars of different inoculation times was tested. Peppi cultivar had yield losses caused by anthracnose that ranged from 24 to 43% (or from $1500 to $2900/ha) when disease levels ranged from 4 to 50%, compared with the fungicide-protected plants. Triple Mech cultivar had yield losses ranging from 10 to 29% (or from $700 to $2100/ha) when disease levels ranged from about 5 to 50%, compared with the fungicide-sprayed plants. Yield of Peppi was generally less than that of Triple Mech at similar inoculation times. Late inoculations resulted in lower yield losses.

Parsnips. A major constraint on parsnip production in recent years in the Bradford region has been the occurrence of a fungus disease of unknown etiology affecting the petioles and leaves. A disease survey of parsnips in the Bradford region was undertaken in 1983. Parsnip petiole canker was the major fungus problem encountered on muck and mineral soils, with incidence ranging from trace levels to about 80% of plants affected. Canker was randomly scattered in fields, and on individual plants it could be found at any location on the petioles. Gradual chlorosis followed by necrosis of the foliage was observed on plants having the cankers. Canker was first observed in early August and was associated with inadequate or poor fungicide application and weed infestation. The etiology and epidemiology of parsnip petiole canker are being investigated.

Muskmelon. Thirty-four resistant cultivars of muskmelon (*Cucumis melo* L.) reacted differently to *Fusarium oxysporum* f. sp. *melonis* Snyder & Hansen (the muskmelon wilt pathogen) in the greenhouse (22°C, 21 days). The reaction was dependent on the inoculum concentration of the pathogen. The cultivars Superstar and Supermarket remained resistant at the highest inoculum level (approximately 4×10^6 conidia per millilitre), whereas the cultivar Samson was susceptible at the lowest inoculum level (approximately 3×10^3/mL). The resistance of the remaining cultivars ranged between these extremes. This work will help extension agents in recommending to farmers the specific cultivars to plant in wilt-infested fields.

ORNAMENTALS

Insects

Greenhouse ornamental pest management. Chrysanthemum leafminer, *Liriomyza trifolii* (Burgess), is still the major pest of floriculture in Ontario. A total of 19 alternate hosts (all common weeds) containing *L. trifolii* larvae were found during the summers of 1982 and 1983 around commercial greenhouses that produced chrysanthemums. Parasitic wasps (Hymenoptera: Braconidae and Eulophidae) were collected emerging from these weed hosts. Therefore, although the leafminer population outside the greenhouse is a potential reservoir of individuals to reinfest it, high levels of parasitism outside may restrict this movement.

New insecticides have been evaluated for efficacy against leafminer adults and larvae. Four new pyrethroid compounds were as ineffective as permethrin except when a synergist, piperonyl butoxide, was added. This indicated that the leafminer has metabolic cross-resistance to new pyrethroids. The two most promising new compounds for control of this pest are pyrazophos (Afugan), for control of larvae and adults, and cyromazine (Trigard), for control of larvae. The latter, an insect growth regulator, is particularly promising in terms of chrysanthemum IPM because of its selectivity (that is, it is nontoxic to beneficial insects and mites).

Seventeen cultivars of *Chrysanthemum morifolium* Ramat, grown for cut-flower production in Ontario, varied significantly in leaf damage by leafminers. The total number of leaf mines on the top 10 marketable leaves at harvest ranged from 37.1 for White Iceberg to 1.3 for Statesman. The two standard-type cultivars, Colonel Comfort and Southern Gold, had significantly less mines than 14 spray-type cultivars. Counting numbers of leaf mines was an effective method of assessing resistance among cultivars at the population levels of leafminers released into the greenhouse in this study.

Nematodes

Stubby-root nematode in tree nurseries. Damage to 2-yr-old white pine seedlings was first associated with stubby-root nematodes, *Paratrichodorus pachydermis*, in 1981. Field-grown seedlings had reduced root systems and mycorrhizal development, and showed clusters of short lateral roots surrounded by a gelatinous gum. Foliar symptoms included stunted and chlorotic terminal needle clusters with a tendency to wilt and die-back from the tips. Pathogenicity was complicated by the presence of several fungi. White spruce also had stubby-root nematode present in large numbers, but the main symptom was needle sparseness and defoliation. Since the pathogenicity of the nematode to white pine has not yet been described, nematodes are being reared and pathogenicity studies are at an early stage. Field tests with three fumigants and nine nursery-tree species were established to determine which trees respond to nursery fumigation. Only black walnut seedlings have been found to be free from the nematode thus far. After 1 yr, control of the nematode was satisfactory with a liquid fumigant at three rates ranging from nematicidal to fungicidal; fungicidal rates of a granular fumigant also suppressed nematodes; but a second liquid fumigant was less effective at all rates. Control of the disease complex is essential, because several million seedlings for reforestation have been lost since the problem was first recognized.

Diseases

Bacterial leaf spot/black stem necrosis of chrysanthemum. Pseudomonas cichorii has been identified as the cause of a disease new to Canada. Seventeen cultivars have been tested for susceptibility to the bacterium and several key questions have been answered. Warmer temperatures favor infection, but free water is necessary for infection and symptom development. The bacterium can be spread when hard or soft pinches are made.

Even in heavily infected plants the bacterium does not systemically infect the plant. Severely infected plants outgrow symptoms when kept under dry conditions (low relative humidity and no splashing water) for 4 wk. Healthy-appearing cuttings taken from these plants are free from the bacterium.

Fusarium root rot of Exacum. Fusarium solani, causing a root rot and basal stem canker of Persian violet, *E. affini*, can be controlled by soil drenches of benomyl or carbendazim at an a.i. rate of 0.6 kg/kL. It appears that two drenches are necessary, at potting and again 4 wk later. Data will be provided to obtain minor-use registration of Benlate 50 W on *E. affini*.

Botrytis strains resistant to fungicide iprodione. B. cinerea resistant to iprodione (Rovral) has been found in 12 out of 20 greenhouses sampled in Ontario. The level of resistance is being determined and the *Botrytis* strains are being tested for aggressiveness in order to determine the significance to growers. Iprodione is the only registered spray fungicide that growers can use to control *Botrytis* in greenhouses.

SMITHFIELD EXPERIMENTAL FARM

Potatoes

Hollow heart of potatoes. Mineral gradients in potato tubers showing symptoms of the physiological disorder hollow heart were determined using X-ray microanalysis techniques. Developing tubers with incipient stages of hollow heart revealed a dramatic increase in Mg in lesion areas. A localized Mg toxicity or Ca deficiency due to high Mg:Ca ratio is implicated in the onset of cell necrosis that characterizes the initiation of hollow heart. Mature tubers with advanced symptoms of the disorder had elemental gradients similar to those of healthy control tubers. This suggests that if the disorder is caused by an elemental deficiency, as has been proposed, the deficiency is temporary and no longer exists in mature tubers with advanced hollow heart.

Ontario potato cultivars as chips and french fries. Tuber samples from the Ontario Regional Potato Trials are evaluated each year at Smithfield. Some cultivars with yellow flesh, a color traditionally accepted overseas but not in Canada, have made high-quality products. There are indications that yellow-fleshed chips and french fries may become acceptable commercially in this country. The yellow-fleshed seedling G742-4y gave the highest average chip score in the 1982 trials. Russet Burbank and Norchip rated highest overall for french fry quality of white-fleshed varieties. Russet Burbank was not acceptable for chips.

Tomatoes

Composition of Ontario tomatoes. Dry solids, N, P, K, Ca, and Mg contents of fresh and canned tomatoes grown at Smithfield in 1982 were slightly lower (in some cases comparable) than general values for U.S.-grown tomatoes reported by the U.S. Department of Agriculture. Our values for solids content in the past 6 yr have ranged from below to above those reported in USA. Studies of mineral content of locally grown fruit are continuing in order to assess seasonal variations.

Nightshade competition in tomato fields. Nightshade populations from 0 to 160 plants per square metre were established in tomato plots. Heavy natural populations of American nightshade and hairy nightshade were present in the experimental area. Other weed species were removed. A nightshade population as low as 10/m^2 reduced the tomato yield from 19.0 t/ha in the check to 8.2 t/ha. Because of the spreading growth habit of nightshade, a few plants are able to compete successfully with tomatoes. Herbicides currently being tested gave some early-season control but none performed satisfactorily for the entire growing season.

Apples

Trickle irrigation for apples. The response from trickle irrigation is much greater if watering is started early in the life of the orchard rather than waiting until trees are already established. Improvements in total yield, cumulative yield, and trunk girth were noted for trees irrigated from the year after planting. Fruit size was also increased in a dry year. When trickle irrigation was started in the 6th yr after planting at the same location, an increase in fruit size and average terminal growth was noted some years, but there was no noticeable improvement in total yield.

Spacing trials with McIntosh. McIntosh was planted in a hedgerow 5 m × 3 m in 1971 with MM 106 and *M. robusta* 5 rootstocks on a clay loam soil. The total accumulated yield on *M. robusta* 5 was 9% higher than on MM 106 but the production of Canada Fancy colored fruit was 17% or 38 t/ha higher with the MM 106 rootstock. The annual application of Alar plus Ethrel in the last week of June increased the total accumulated yield of McIntosh by 23% and the yield of fancy fruit by 45%. Over the 13 yr, total production was increased 45.8 t/ha on *M. robusta* and yield of fancy fruit by 55 t/ha using the growth regulator spray as an orchard management tool. On these vigorous trees the reduction in fruit size due to Alar plus Ethrel was an advantage in terms of better-quality McIntosh fruit for storage.

PUBLICATIONS

Research

Biggs, A. R.; Davis, D. D.; Merrill, W. 1983. Histopathology of cankers on *Populus* caused by *Cytospora chrysosperma*. Can. J. Bot. 61:563-574.

Bisessar, S.; Rinne, R. J.; Potter, J. W. 1983. Effects of heavy metals and *Meloidogyne hapla* on celery grown on organic soil near a nickel refinery. Plant Dis. 67:11-14.

Cerkauskas, R. F.; Dhingra, O. D.; Sinclair, J. B. 1983. Effect of three desiccant-type herbicides on fruiting structures of *Colletotrichum truncatum* and *Phomopsis* spp. on soybean stems. Plant Dis. 67:620-622.

Cerkauskas, R. F.; Dhingra, O. D.; Sinclair, J. B.; Asmus, G. 1983. *Amaranthus spinosus*, *Leonotis nepetaefolia*, and *Leonurus sibiricus*, new hosts of *Phomopsis* spp. in Brazil. Plant Dis. 67:821-824.

Chiba, M.; Veres, D. F.; Townshend, J. L.; Potter, J. W. 1983. Redistribution of oxamyl from treated seeds to peach seedlings and soil as determined by high performance liquid chromatography. J. Agric. Food Chem. 31:53-58.

Frank, R.; Stonefield, K. I.; Suda, P.; Potter, J. W. 1982. Impact of nickel contamination on the production of vegetables on an organic soil, Ontario, Canada, 1980–1981. Science of the Total Environment 26:41-65.

Graham, V.; Bilanski, W. K.; Menzies, D. R. 1983. Adsorption grain drying using bentonite. Trans. Am. Soc. Agric. Eng. 26(5):1512-1515.

Hagley, E. A. C.; Simpson, C. M. 1983. Effect of insecticides on predators of the pear psylla, *Psylla pyricola* (Hemiptera: Psyllidae) in Ontario. Can. Entomol. 115:1409-1414.

Hagley, E. A. C. 1983. Pesticides, pollination and fruit set on apple. Can. Entomol. 115:1535-1536.

Harcourt, D. G.; Yee, J. M.; Guppy, J. C. 1983. Two models for predicting the seasonal occurrence of *Agromyza frontella* (Diptera: Agromyzidae) in Eastern Ontario. Environ. Entomol. 12(5):1455-1458.

Matteoni, J. A.; Sinclair, W. A. 1983. Stomatal closure in plants infected with mycoplasmalike organisms. Phytopathol. 73:398-402.

Olthof, T. H. A.; Anderson, R. V.; Squire, S. 1983. Plant parasitic nematodes associated with potatoes (*Solanum tuberosum* L.) in Simcoe County, Ontario. Can. J. Plant Pathol. 4:389-391.

Stevenson, A. B. 1983. Seasonal occurrence of carrot rust fly (Diptera: Psilidae) adults in Ontario and its relation to cumulative degree-days. Environ. Entomol. 12(4):1020-1025.

Sturton, S. L.; Bilanski, W.; Menzies, D. R. 1983. Moisture exchange between corn and the desiccant bentonite in an intimate mixture. Can. Agric. Eng. 25(1):139-141.

Townshend, J. L.; Pree, D. J.; Broadbent, A. B. 1983. Population development and reproduction of fungus- and bacterium-feeding nematodes in the presence of insect growth regulators. J. Nematol. 15:105-110.

Trimble, R. M. 1983. Reliability of degree-day indices for predicting spring emergence of the spotted tentiform leafminer, *Phyllonorycter blancardella* (Lepidoptera: Gracillariidae), in Ontario. Can. Entomol. 115:393-398.

Trimble, R. M. 1983. Diapause termination and the thermal requirements for postdiapause development in six Ontario populations of the spotted tentiform leafminer, *Phyllonorycter blancardella* (Lepidoptera: Gracillariidae). Can. Entomol. 115:387-392.

Trimble, R. M. 1983. Potential of a temperature zone *Toxorhynchites* for the biological control of tropical container-breeding mosquitoes. Mosq. News 43:71-73.

Trimble, R. M.; Lund, C. T. 1983. Intra- and interpopulation variation in the thermal characteristics of preadult development of two latitudinally diverse populations of *Toxorhynchites rutilus septentrionalis* (Diptera: Culicidae). Can. Entomol. 115:659-662.

Miscellaneous

Allen, W. R.; VanSchagen, J. G. 1982. The virus-tested grapevine program at Vineland. Can. Agric. 4:10-13.

Biggs, A. R. 1983. Black knot of plums and cherries. OMAF Agdex 83-026.

Broadbent, A. B. 1982. *Liriomyza trifolii* on chrysanthemums in Ontario greenhouses. Pages 90-100 *in* Poe, S. L., ed. Proc. 3rd Annu. Industry Conf. on Leafminer, San Diego (Nov. 1982). 216 pp.

Mohr, W. P. 1982. Elemental gradients associated with hollow heart in potato: Studies using X-ray microanalytical techniques. Agric. Can., Smithfield Experimental Farm, Tech. Bull. No. 5.

Northover, J. 1983. A strategy for the control of *Botrytis cinerea* on grapes. Proc. 15th Penn Wine Conf. 1983, pp. 30-32.

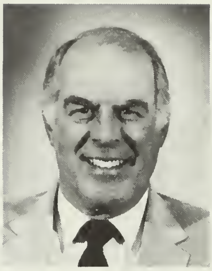
Roberts, W. P.; Pree, D. J. 1983. Pest management program for peaches: Tarnished plant bug. OMAF Agdex 83-027, 3 pp.

Timbers, G. E.; Hocking, R. P.; Jessop, D. B.; Mohr, W. P. 1982. A chopper/stirrer for tomato cultivar evaluation. Agric. Can., Eng. Stat. Res. Inst., Tech. Rep. I-455.

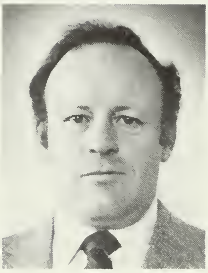
Warner, J. 1983. Observations on winterhardiness of apples and pears. Canadex 211.31.

Yee, J. M.; Harcourt, D. G. 1983. SIMWEEVIL/SIMABL: An IPM monitoring system for the alfalfa weevil and alfalfa blotch leafminer. Res. Branch, Agric. Can. 1983-5E. 33 pp.

PRAIRIE REGION
RÉGION DES PRAIRIES



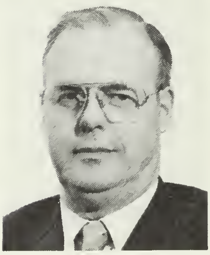
Dr. W. L. Pelton



Dr. J. E. Knipfel

Mr. H. C. Korven

Mr. D. D. Jones



Mr. J. J. McConnell

EXECUTIVE OF THE PRAIRIE REGION
L'EXÉCUTIF DE LA RÉGION DES PRAIRIES

Director General
Directeur général
W. L. Pelton, B.S.A., M.S.A., Ph.D.

Program Specialist
Spécialiste en programmes
J. E. Knipfel, B.S.A., M.Sc., Ph.D.

Contracts Specialist
Spécialiste en contrats
H. C. Korven, B.E., M.Sc.

Acting Chief, Administration
Chef intérimaire, administration
D. D. Jones

Regional Communication Specialist
Spécialiste régional en communication
J. J. McConnell, B.S.A., M.A.
Seconded from Communications Branch, Ottawa
Détaché de la Direction générale des communications (Ottawa)

PREFACE

The Prairie Region, established on 15 August 1983, consists of ten research stations, three experimental farms, and five substations, which serve agriculture throughout the Prairie Provinces. In 1983 the Region managed a budget of $50 million and employed approximately 265 professionals and 840 support staff in carrying out its research programs. The following are some highlights of achievements in the Region in 1983.

Cultivars of crops licensed were Morden 12 sunflower, NorMan flax, and Signal bromegrass. In addition, four sunflower inbreds were released.

Natural resources research emphasizes efficient use of soil, water, and energy without contamination of our environment. Research this year showed that Landsat imagery is an effective way to map saline soil areas; organic liners effectively reduce seepage losses from irrigation canals and farm dugouts; and municipal sewage effluent can be safely used to irrigate forage crops. Results also showed that diesel–propane mixtures for use in farm trucks and tractors can increase net farm income by 6–7% despite modification costs.

Animal production research aims to increase production efficiency. Supplementation of hay diets with canola meal increased growth rate and feed efficiency of steers by 13% while ammoniation of cereal chaff increased digestible energy from 15% to 30%. A complementary grazing system of 40% seeded pasture and 60% native range increased beef production by 130% over production from native grass alone. Placing pigs on pasture was effective in alleviating leg weakness problems.

A reduction in summerfallow hectarage through the extension of cereal crop rotations not only reduces erosion, salinity, and other soil-degradation problems but also provides economic advantages to wheat producers. The application of biotechnology procedures is beginning to accelerate plant-breeding programs. Nodding thistle is being successfully controlled by a seed-feeding insect.

Prairie Region managed the agricultural engineering research and development (AERD) (mechanization and farm buildings) contract programs for wild oat control and vertebrate pest control for the Branch and the Station Initiatives Program for the Prairie and Pacific regions. Thirty-six scientists monitored 62 contracts valued at $4.3 million, 52% with industry.

Ten unsolicited contract research proposals and five extramural research proposals were approved for funding. The Alberta Research Council's Farming for the Future program funded 43 projects for $2.7 million.

Achievements from research done under contract included development of a night shutter on a greenhouse to reduce night heat losses and an air-to-air heat exchanger to recover energy from exhaust air and to control humidity. Two automatic depth-control systems and a large round bale stacker (AERD contracts) were carried to the commercial stage by contracts under the program for industry/laboratory projects (PILP). An electrostatic sprayer improved uniformity of applications, saving labor and reducing the amount of insecticides needed. A lowbush blueberry harvester and a potato harvester were developed in the Maritimes. An extension bulletin was prepared based on contracts to study toxic gases in silos. Basic data on physiology of dormancy and persistence of wild oats and the behavior of wild oat herbicides are being obtained by contracts with universities.

During 1983, Dr. J. E. Andrews, Director General, Western Region, was appointed Senior Adviser to the Assistant Deputy Minister, Research. Other management appointments included Dr. T. G. Atkinson, Director, Winnipeg Research Station; Dr. D. G. Dorrell, Director, Lethbridge Research Station; Dr. D. M. Bowden, Director, Swift Current Research Station; and Dr. J. E. Knipfel, Program Specialist. Mr. W. E. Towill, Superintendent, Indian Head Experimental Farm, retired in 1983 after 35 yr of service. Mr. Ian Wood, Chief of Administration, Western Region, was granted a 2-yr leave of absence to serve with the Branch's project in Tanzania. Mr. D. Jones assumed these responsibilities in his absence.

Further information may be obtained by contacting individual research establishments or by addressing inquiries to Prairie Region Headquarters, Research Branch, Agriculture Canada, P.O. Box 9241, Saskatoon, Sask. S7K 3X5.

W. L. Pelton

PRÉFACE

La Région des Prairies a été créée le 15 août 1983. Elle comprend dix stations de recherches, trois fermes expérimentales et cinq sous-stations qui desservent l'agriculture de toutes les provinces des Prairies. En 1983, la Région a disposé d'un budget de 50 millions de dollars et a employé dans ses divers programmes de recherches quelque 265 professionnels en plus d'un personnel de soutien de 840 employés. Nous citerons ci-après quelques-unes de ses réalisations principales durant 1983.

Les cultivars homologués ont été le tournesol Morden 12, le lin NorMan et le brome Signal. En outre quatre lignées de tournesol ont été présentées.

La recherche consacrée aux ressources naturelles a porté sur l'utilisation efficace des sols, de l'eau et de l'énergie en évitant la contamination de l'environnement. Les images transmises par le satellite Landsat constituent un moyen efficace de délimiter les zones à sols salins; les revêtements organiques se sont avérés utiles pour réduire les fuites dans les canaux d'irrigation et les étangs de ferme; et l'on a pu irriguer avec sécurité des cultures fourragères à l'aide d'effluents des eaux-vannes municipales. L'utilisation d'un mélange Diesel – propane dans les camions et les tracteurs agricoles peut améliorer de 6 à 7 % le revenu net des fermes malgré les dépenses de modifications qui s'imposent.

La recherche du côté des productions animales vise à en accroître l'efficacité. En ajoutant de la farine de canola aux régimes à base de foin servis aux bouvillons, on a pu augmenter de 13 % le taux de développement et la conversion alimentaire. De son côté, l'ammonisation des balles de céréales en a amélioré de 15 à 30 % l'énergie digestible. Un système de paissance complémentaire à raison de 40 % de pâturage ensemencé et 60 % de pâturage naturel a produit une augmentation de 130 % de la production du boeuf de boucherie comparativement à celle obtenue en pâturages naturels seuls. Le séjour des porcs en pâturage permet fréquemment d'atténuer les cas de faiblesse des membres.

La diminution des superficies en jachère d'été grâce au développement de la rotation des cultures céréalières permet non seulement de réduire les méfaits de l'érosion, de la salinité et d'autres facteurs de dégradation des sols, mais apporte des avantages économiques aux producteurs de blé. Les applications de la biotechnologie commencent à accélérer les programmes de sélection des plantes. Un insecte qui se nourrit des graines du chardon penché s'est révélé efficace contre cette plante adventice.

La Région des Prairies a régi les programmes de recherches contractuelles pour la Recherche et le Développement en génie rural (mécanisation et bâtiments agricoles) ayant pour objet la lutte contre la folle avoine et les parasites vertébrés, pour le compte de la Direction générale et du Programme d'initiatives des stations, dans les régions des Prairies et du Pacifique. Trente-six chercheurs ont dirigé 62 de ces contrats évalués à 4,3 millions de dollars (52 % avec l'industrie).

Des subventions ont été approuvées pour 10 propositions de contrat non demandées ainsi que pour cinq propositions de recherches à l'extérieur. On a financé 43 projets dans le cadre du programme «l'Agriculture dans l'avenir» du Conseil de recherches de l'Alberta, pour un montant de 2,7 millions de dollars.

Les réalisations découlant des travaux de recherches sous contrat comprennent: un système de volets permettant de réduire les pertes nocturnes de chaleur des serres, et un échangeur de chaleur récupérant l'énergie de l'air expulsé et réglant l'humidité. Deux dispositifs automatiques de réglage de la profondeur et un entasseur de grandes balles rondes (contrats R.D.G.R.) sont rendus au stade commercial en vertu de contrats du Programme de projets pour l'industrie et les laboratoires (P.I.L.P.). Un pulvérisateur électrostatique permet d'améliorer l'uniformité des arrosages tout en économisant sur la main-d'oeuvre et les insecticides. Pour les Maritimes, on a mis au point une récolteuse pour bleuets nains ainsi qu'une récolteuse de pommes de terre. Un bulletin de vulgarisation a été préparé sur une base contractuelle pour l'étude des gaz toxiques dans les silos. Des contrats avec les universités permettent de recueillir des informations fondamentales sur la physiologie de la dormance et de la persistance de la folle avoine ainsi que sur les effets des herbicides contre cette plante nuisible.

Au cours de 1983, J.E. Andrews, directeur général pour la Région de l'Ouest, a été nommé conseiller principal du sous-ministre adjoint à la Recherche. Parmi d'autres nominations administratives, mentionnons T.G. Atkinson, directeur de la station de recherches de Winnipeg; D.G. Dorrell, directeur de la station de recherches de Lethbridge; D.M. Bowden, directeur de la station de recherches de Swift Current, et J.E. Knipfel, spécialiste des programmes. W.E. Towill, surveillant en chef de la ferme expérimentale d'Indian Head a pris sa retraite en 1983 après 35 ans de service. Ian Wood, chef de l'administration pour la Région de l'Ouest s'est vu accorder un congé de 2 ans durant lequel il s'occupera d'un projet de la Direction général en Tanzanie. D. Jones l'a remplacé dans ses fonctions précédentes.

Les personnes intéressées peuvent obtenir de plus amples renseignements en s'adressant aux divers établissements de recherches concernés ou en écrivant au siège de la Région des Prairies, Direction générale de la recherche, Agriculture Canada, C.P. 9241, Saskatoon (Sask.) S7K 3X5.

W.L. Pelton

Research Station
Brandon, Manitoba

PROFESSIONAL STAFF

Administration

B. H. SONNTAG, B.S.A., M.Sc., Ph.D.	Director
G. JOHANNSON[1]	Administrative Officer
VACANT	Information Officer
R. J. BOMFORD,[2] B.Sc., M.Sc.	Systems and programming

Animal Science

G. W. RAHNEFELD, B.Sc., M.Sc., Ph.D.	Head of Section; Beef cattle breeding
A. G. CASTELL, B.Sc., M.Sc., Ph.D.	Swine nutrition
R. L. CLIPLEF, B.Sc., M.Sc., Ph.D.	Meats physiology
G. W. DYCK, B.S.A., M.Sc., Ph.D.	Reproductive physiology
R. R. GRANDHI, B.V.Sc., M.Sc., Ph.D.	Swine nutrition
D. L. GRINWICH, B.Sc., M.Sc., Ph.D.	Reproductive physiology
R. M. MCKAY, B.Sc., B.S.A., M.Sc., Ph.D.	Swine genetics

Plant Science

L. D. BAILEY, B.S.A., M.Sc., Ph.D.	Head of Section; Soil–plant relationships
P. N. P. CHOW, B.S.A., M.A., Ph.D.	Weed physiology
R. D. DRYDEN, B.S.A., M.Sc.	Crop culture
C. A. GRANT,[3] B.S.A., M.Sc.	Oilseed agronomy
R. B. IRVINE, B.S.A., Ph.D.	Barley physiology
W. N. MIGUS,[4] B.Sc., M.Sc., Ph.D.	Corn physiology
J. M. SADLER, B.Sc., M.Sc., Ph.D.	Plant nutrition
R. SIMONS, B.Sc., M.Sc., Ph.D.	Forage agronomy
M. C. THERRIEN, B.Sc., Ph.D.	Barley breeding

Departures

S. BUKOWSKI Resigned August 1983	Administrative Officer
C. A. GRANT Resigned September 1983	Information Officer
R. I. HAMILTON Transferred to Ottawa Research Station, January 1983	Corn physiology
M. BUHR Resigned August 1983	Natural Sciences and Engineering Research Council Fellow

---

[1] Appointed December 1983.

[2] Seconded from Systems and Consulting Directorate, Finance and Administration Branch.

[3] Appointed September 1983, Ph.D. trainee.

[4] Appointed June 1983.

INTRODUCTION

The research program at Brandon encompasses beef cattle breeding; swine nutrition, physiology, genetics, and management; breeding, physiology, and management of barley, corn, soybeans, and sorghum; and soil fertility, agronomy, plant nutrition, and weed control in cereal, oilseed, and forage crops. Research programs are designed to solve production problems and to evaluate new opportunities that will enable Canadian farmers, especially those located in the eastern prairie area, to maintain or improve their competitive position in domestic and foreign markets.

Dr. R. I. Hamilton, corn physiologist, transferred to the Ottawa Research Station in January as a corn breeder and was replaced in June by Dr. W. N. Migus. Mrs. C. A. Grant resigned as the Information Officer to accept a trainee position in oilseed agronomy in the Branch Ph.D. training program. Ms. S. Bukowski resigned in August from the Administrative Officer position and was replaced in December by Mr. G. I. Johannson. Dr. M. Buhr resigned from a Natural Sciences and Engineering Council postdoctoral fellowship in August to accept an appointment in animal science at the University of Manitoba.

This brief report contains highlights of recent findings of our research program. More detailed results can be obtained from our annual Review of Results, from published papers, or by direct contact with research personnel at the Research Station, Research Branch, Agriculture Canada, Box 610, Brandon, Man. R7A 5Z7.

B. H. Sonntag
Director

ANIMAL SCIENCE

Beef cattle

Carcass characteristics were compared for 3673 steers and heifers born over a 6-yr period 1973–1978 at Brandon, Man., under farm conditions, and Manyberries, Alta., under range conditions. Calves weaned at Manyberries were fed and evaluated at Lacombe, Alta. Calves born at Brandon were fed and evaluated at Brandon. The progeny were out of 10 specific F_1 crosses of dams mated to bulls of the Charolais (C), Simmental (S), Limousin (L), and Chianina (Chi) breeds. Dam crosses included the Hereford × Angus (HA) and crosses sired by C, S, and L sires out of H, A, and Shorthorn (N) dams. Breed of sire of dam effects indicated that progeny from S cross cows generally had the heaviest carcasses $S = C > L$, the greatest carcass weight per day of age $S = C > L$, the highest percentage of dissected bone of the round $S > C > L$ and rib $S > C = L$, the highest proportion of brisket $S > L > C$ and flank $S > L = C$, and carried more kidney fat (percentage of liveweight) $S > C = L$ and average rib fat $S > C = L$. Progeny from L and C cross cows had the highest dressing percentage $L \geq C > S$ and rib eye area/100 kg carcass weight $L > C > S$, whereas those from L cross cows had the highest proportion of long loin and combined lean cuts (rib, round, and long loin), a higher percentage of dissected lean in the round $L > C > S$, and the highest lean to bone ratio $L > C > S$. Progeny from dams of N breeding generally had the heaviest carcasses, the greatest carcass weight per day of age, the highest percentage kidney fat and, at Brandon, the greatest proportions of plate and brisket. H cross dams consistently produced progeny with the highest percentage head $H = A > N$, hide $H \geq A > N$, feet $H > A = N$, percentage bone in the long loin $H \geq A = N$, round $H > N \geq A$, and rib $H > N \geq A$, and the highest percentage lean in the long loin $H > N$ (Brandon) and chuck $H > N$ (Brandon). The progeny from A cross dams carried the greatest average rib fat $A \geq N$, had the greatest rib eye area/100 kg carcass weight $A \geq H = N$, the highest percentage lean in the round $A \geq H = N$, and the highest lean to bone ratio $A > H = N$.

Swine

Predictions of the effectiveness of intrapopulation selection versus selection for specific combining ability in swine. Estimates of additive genetic variance in purebreds (Lacombe) and crossbreds (Lacombe ×

Yorkshire) and the additive genetic covariance between purebreds and crossbreds were calculated for average daily gain, total probe fat, total carcass fat, and litter size. These parameter estimates were used to determine whether intrapopulation selection (purebred selection) was more effective than selection for specific combining ability (selection based on crossbred performance) in improving crossbred performance. Purebred selection was more effective for average daily gain and selection for crossbred performance for litter size. Total probe and carcass fat favored either method, depending on the magnitude of the relative selection intensity between purebred selection and selection based on crossbred performance.

Influence of dietary calcium–phosphorus levels on mineral and nitrogen absorption in gilts. The effect of feeding 150% of 1979 National Research Council-recommended Ca–P levels of absorption (g/day) of Ca, P, Mg, and N was determined in Lacombe and Yorkshire gilts during three periods: at 150 days of age during finishing, at 60 days of gestation, and at 21 days of lactation. Higher Ca–P levels increased ($P < 0.05$) Ca and P absorption during all three periods, whereas Mg absorption was increased during finishing and lactation periods. Ca and P absorption in general was higher during gestation and lactation than during the finishing period. N absorption was decreased ($P < 0.05$) by higher Ca–P levels during the finishing period. Yorkshire gilts had lower N absorption during finishing and higher P absorption during gestation than Lacombe gilts, suggesting breed differences in nutrient absorption. These results indicate that increased dietary Ca–P levels have no adverse effect on absorption of Ca, P, Mg, and N during gestation and lactation periods in gilts.

Puberty induction in swine. In an attempt to identify a potential cause of puberty induction failure in gilts, uterine estrogen receptors were quantitated in pregnant cycling and puberty-induced female pigs. Two classes of estrogen binding sites were identified. Pregnant animals exhibited elevated high-affinity estrogen binding sites when compared to cycling or puberty-induced gilts. The fact that high-affinity binding sites for estrogen in cycling and puberty-induced gilts were not significantly different failed to confirm the hypothesis that an absence of estrogen receptors might be the factor for the high failure of puberty induction in gilts when gonadotropic hormones are administered.

Luteal cell studies. Studies on the action of lipoproteins on pig and rat luteal cells indicate that prolactin in addition to stimulating progesterone secretion can also induce lipoprotein uptake. The studies are continuing to advance understanding of hormone–lipoprotein interaction and their control of luteal function and estrus cycle activity.

Postmating feeding level effects on conception rate and embryonic survival in gilts. Restriction of feed intake for the first 10 days after mating to near body weight maintenance (0.12 kg/day) as compared to a moderate growth rate (0.42 kg/day) resulted in an increase in embryonic survival (85 versus 76%) and litter size (11.2 versus 9.5) at 30 days of pregnancy. When the feed intake restriction was imposed on day 10, there was no effect on embryonic survival (77%) or litter size (9.6). When the feed intake restriction was continued from breeding to day 30, the high embryonic survival and litter size were maintained but the pregnancy rate was reduced (64 versus 87%). Ovulation rate was not affected by the treatments. Thus, restriction of feed intake to near body weight maintenance for 10 days after mating may be an effective means of increasing litter size in gilts.

Postweaning changes in the reproductive tract of the sow. Growth changes were determined from weaning to day 10 of the estrous cycle. Ovarian weight showed only a small increase from weaning to estrus (7.8 to 8.2 g) and was associated with an increase in size of a portion of the vesicular follicles. After ovulation there was a decline in ovarian weight (6.0 g), which was followed by an increase in weight with growth of the corpora lutea (13.2 g on day 10). Large (>6 mm diameter) follicles were observed only at the time of estrus. Oviduct and cervix weight and length increased from weaning to estrus and subsequently declined to day 10. These growth changes appeared to follow the growth of the ovarian follicles. Uterine weight but not length also followed the pattern of follicle growth from weaning to estrus (137 to 371 g). After estrus there was a decline in uterine weight (278 g) followed by an increase in weight to day 10 (455 g). Uterine length increased from day 8 (151 cm) to day 10 (264 cm). Thus, the growth of the oviduct and cervix was associated only with preovulatory follicle growth, whereas uterine growth was associated with the growth of both the follicle and the corpora lutea.

Boar exposure and the duration of estrus in postweaning sows. The effect of maximum or minimum boar exposure on the duration of estrus was determined on 28 primiparous Lacombe sows observed in estrus within 10 days of weaning. The sows were housed either adjacent to mature boars and checked for estrus for 30 min each day with vasectomized boars or away from the boars and checked for 5 min each day. Twelve sows with maximum boar exposure averaged 1.6 days in estrus, whereas 16 sows with minimum boar exposure averaged 2.4 days in estrus. These results indicate that the duration of estrus is decreased with continuous exposure to mature boars.

Canola meal as a protein source. Four diets, representing two wheats (15.6 and 13.2% CP (crude protein)) and two levels of canola meal (5 and 15%), and two barley-based, 16% CP diets (containing 22% canola meal or 15% soybean meal) were evaluated in growth, digestibility, and palatability studies using market pigs. Among the pigs self-fed the four 16% CP diets, live performance and carcass measurements favored the barley diets. Increasing the canola meal supplementation of both wheats improved live performance and carcass quality. Apparent digestibilities of energy and nitrogen were relatively higher in the wheat diets and were not affected by the canola meal level. Raising the canola meal level reduced diet palatability and suggested that this factor may determine the optimum inclusion rate in balanced diets.

Flavomycin for finishing pigs. Performance of 144 market pigs, representing both Lacombe and Yorkshire breeds, was used to compare two levels, 0 and 2.2 ppm, of Flavomycin (bambermycins) in a 14.5% finisher diet fed, ad libitum, from 35 to 90 kg liveweight. Although there was a range in the effects on growth rate (–13.3% to +8.4%) and gain-feed ratio (–7.6% to +8.1%) between matched pens, overall responses to inclusion of the growth promotant were negligible ($P > 0.05$) for live performance and carcass measurements. The rapid gains of the unsupplemented pigs (0.84 kg/day) or a low incidence of susceptible micro-organisms may have been responsible for the lack of efficacy observed.

Consumer acceptance of fresh pork and pork products. Forty-eight consumer families received analogous samples of ham, bacon, sausage, fresh roasts, and fresh pork chops from both boars and littermate barrows. Families rated the cooked samples for odor, flavor, and tenderness and indicated their preference. There were no significant differences in organoleptic scores for any of the products tested, but consumers preferred products from barrows more often than products from boars. Boars had higher levels of 5α-androstenone in loin fat and significantly higher levels in ham fat ($P < 0.01$). Levels of androstenone did not differ significantly after curing and smoking. Boar bacon and hams shrank significantly more ($P < 0.05$) during processing than those of littermate barrows.

PLANT SCIENCE

Other cereals

Barley breeding and physiology. The principal objective of the new barley breeding and physiology program is development of two- and six-row disease-resistant malting varieties superior to those now available. New high-yielding feed varieties will be by-products of the program. To meet these objectives, a base population of barley cultivars has been developed in which male sterile facilitated crossings can occur and selections made for dry matter and harvest index. New crosses displaying high yield, strong straw, good malting quality, and resistance to loose smut and stem rust have been made, as well as crosses to incorporate other potentially useful traits. Testing of the resulting hybrids for combined disease resistance and good agronomic performance is under way and preliminary results are promising.

Thirty hybrid hulless barley genotypes have been produced for use in the development of hulless feed varieties. These genotypes combine desirable agronomic characteristics and resistance to true loose smut (*Ustilago nuda*), as well as field tolerance to various barley leaf diseases.

Weed control in barley and wheat. New candidate herbicides, WL 43423 and AC 222,293, isomers of Mataven and Avenge, respectively, gave better control of wild oats than the currently licensed wild-oat control herbicides. Use of herbicides for the control of broad-leaved weeds did not result in antagonistic effects when mixed with these isomers.

Winter wheat production. Investigation of winter survival of Northstar and Winalta winter wheat showed that the application of N fertilizer decreased survival, particularly in the absence of P fertilizer. Application of P fertilizer increased survival. However, percentage of grain protein increased with increasing rates of N, whereas the highest grain yield was obtained with a combination of N fertilizer at 120 kg/ha and P fertilizer at 21.7 kg/ha.

Sorghum physiology and management. Evaluation of recently released sorghum hybrids indicates that this crop may become a commercially viable alternative to corn and barley in drought-prone regions with >2100 corn heat units. Two years of field results show sorghum to be very responsive to high rates of applied N. In 1983, when rainfall between seeding and the onset of grain filling was 65% of normal and daily temperatures consistently exceeded 30°C in July through August, yield of grain (15% moisture) and silage (33% dry matter) reached 9.6 and 45 t/ha, respectively, on a clay soil and 4.1 and 36 t/ha, respectively, on a loamy sand soil.

Weed control in corn and sorghum. Spring treatment with EPTC/R25788 gave better weed control in corn than fall application due to a decline in activity over the fall and winter months. Research on loss of activity and reduced weed control when EPTC/R25788 was applied on soils previously treated with the same herbicide indicates that duration of activity can be improved with the addition of an extender, R33865. Rotation of herbicides such as alachlor, cyanazine, and metolachlor have given good control of weeds on soils previously treated with EPTC/R25788.

To date, there are no herbicides registered for use on sorghum in Western Canada. However, good control of weeds in this crop was obtained with postemergence herbicides such as bromoxynil, bromoxynil/MCPA, 2,4-D amine, and dicamba plus 2,4-D amine for broad-leaved weeds; difenzoquat and flamprop-methyl for wild oats; and atrazine for total weed control.

Oilseed crops

Soybean production and management. The quantity of nitrogen fixed by annual legumes (soybean, fababean) is influenced by (*a*) the method of inoculation, (*b*) the Rhizobium strain used, (*c*) the soil and climatic environment, and (*d*) the management of the crop. Group 000 soybeans will obtain 60–65% of their total N requirement from symbiotic dinitrogen fixation when good management, effective strains of Rhizobium, and favorable environmental conditions are combined. Fababeans will obtain 70–80% in the same circumstances. Further, when these crops are used as green manure, there is a net gain in soil N which is beneficial to cereal crops in the rotation. In general, barley following fababean and soybean green manure plow down yielded 28% and 24% more grain and had a 2.9% and 2.7% protein advantage, respectively, over barley grown on summerfallow over a 5-yr period. When the legume crops were harvested for grain, barley yields in the rotation were reduced by 36% (fababean stubble) and 44% (soybean stubble) compared to that obtained on summerfallow; however, protein content was not affected. The addition of N fertilizer at 60 kg/ha to the legume stubble was sufficient to produce yields of barley equivalent to that obtained on summerfallow.

Weed control in flax, canola, and soybean. Two new herbicide formulations of bromoxymil/MCPA at 1:1 ratio (225 g/L designated as AXF 1201 (Bromox) and 360 g/L as AXF 1202 (Sabre)) in combination with BAS 9052, Dowco 453, Hoe 00736, or TF 1195 produced different results in field tests with flax. There was considerable antagonism of wild oat control with TF 1195. AXF 1201 had no antagonism with Dowco 453. However, whereas both formulations had no antagonistic effects on wild oat with Hoe 00736, AXF 1201 gave better control of broad-leaved weeds. The two formulations had no detrimental effect on wild oat control with BAS 9052.

The addition of four non-ionic surfactants (Agral 90, Atplus 411F, Citowett plus, and Renex 36) to chlorsulfuron reduced rapeseed fresh weight by 63% to 81% in comparison to chlorosulfuron applied alone. Except for Atplus 411F, the other three surfactants added to chlorosulfuron solutions gave considerable leakage of solutes from rapeseed leaf-cells to the media, indicating good herbicide penetration.

A mixture of trifluralin and metribuzin as a preemergence treatment gave excellent control of wild oats, lamb's-quarters, and other broad-leaved weeds in soybean, whereas postemergence application of four herbicides CGA 82725, Hoe 00736, RE 6290, and TF 1195 provided excellent control of grassy weeds.

Forage crops

Alfalfa production and management. The rate at which various alfalfa cultivars regrow following cutting is a potentially useful trait that has not been used extensively in selecting plants for breeding purposes on the Canadian prairies. Preliminary results from plants grown in controlled environment indicate that alfalfa genotypes differ considerably in their regrowth, but that the individual genotype's relative performance may not be consistent over a range of conditions. Small plots have been established in the field with high-density planting, simulating a crop, to investigate further the variation in early regrowth.

Grass production and management. In a long-term experiment to investigate the effect of N fertilizer on four grasses (bromegrass, intermediate wheatgrass, crested wheatgrass, and Russian wild ryegrass) plots were established in several years and in each case fertilized and harvested for the three successive years. The response to N fertilizer varied considerably, depending on the year of establishment. This was attributed to the environmental conditions during germination and establishment and in particular to the effects of a severe drought in one harvest season. It appears therefore that results of fertilizer experiments on plots established in only 1 yr should be treated with caution.

Weed control in forage crops. Results from field research supported the registration of the following postemergence herbicides: For the control of wild oats, difenzoquat in sweet clover and difenzoquat and flamprop-methyl in alfalfa; for the control of wild oats, green and yellow foxtail, and barnyard grass, diclofop-methyl in sweet clover. In other experiments, good control of wild oats and green foxtail were obtained with TF 1169 and BAS 9052 plus Atplus surfactant in alfalfa and with TF 1169 in sweet clover.

PUBLICATIONS

Research

Chow, P. N. P. 1983. Herbicide mixtures containing BAS9052 for weed control in flax. Weed Sci. 31:20-22.

Chow, P. N. P.; Taylor, H. F. 1983. Wild oat herbicide studies: 3. Physiological and biochemical bases for interaction of barban and growth regulator herbicide in wild oat. J. Agric. Food Chem. 31:575-578.

Dyck, G. W. 1983. Postweaning changes in the reproductive tract of the sow. Can. J. Anim. Sci. 63:571-577.

Dyck, G. W.; Strain, J. H. 1983. Postmating feeding level effects on conception rate and embryonic survival in gilts. Can. J. Anim. Sci. 63:579-585.

Dyck, G. W.; Swierstra, E. E. 1983. Growth of the reproductive tract from birth to puberty. Can. J. Anim. Sci. 63:81-87.

Grandhi, R. R.; Strain, J. H. 1983. Dietary calcium–phosphorus levels for growth and reproduction in gilts and sows. Can. J. Anim. Sci. 63:443-454.

Grinwich, D. L.; McKibbon, P. E.; Murphy, B. D. 1983. Stimulation of progesterone secretion in the pregnant pig corpus luteum in vitro by prolactin and lipoproteins. Pages 123-127 *in* Greenwald, G. S.; Taranova, P. F., eds. Regulation of ovarian function. Raven Press, New York, NY.

Ivany, J. A.; Sadler, J. M.; Kimball, E. R. 1983. Rate of metribuzin breakdown and residue effects on rotation crops. Can. J. Plant Sci. 63:481-487.

Moyer, J. R.; Dryden, R. D.; Chow, P. N. P. 1983. Fall vs. spring application of EPTC and two antidotes for weed control in corn. Can. J. Plant Sci. 63:227-234.

O'Sullivan, P. A.; Chow, P. N. P.; Hunter, J. H.; Kirkland, K. J. 1983. Control of green foxtail in cereals with AC206784 alone and in mixtures with triallate for wild oat. Can. J. Plant Sci. 62:995-1001.

Rahnefeld, G. W.; Cliplef, R. L.; Garnett, I.; McKay, R. M. 1983. Mass selection for post weaning growth in swine. VI. Means, heritabilities, genetic and phenotypic correlations, and correlated response of carcass traits. Can. J. Anim. Sci. 63:49-58.

Rahnefeld, G. W.; Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A. 1983. Sex and year effects on carcass characteristics of three-way cross beef cattle reared at two locations. Can. J. Anim. Sci. 63:285-298.

Rahnefeld, G. W.; Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A. 1983. Breed of terminal sire effects on carcass characteristics of three-way cross beef cattle reared at two locations. Can. J. Anim. Sci. 63:523-549.

Rahnefeld, G. W.; Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A. 1983. Effects of breed of sire and breed of dam of cow on carcass characteristics of three-way cross beef cattle reared at two locations. Can. J. Anim. Sci. 63:791-802.

Simons, R. G.; Hunt, L. A. 1983. Ear and tiller number in relation to yield in a wide range of genotypes of winter wheat. Z. Pflanzenzuecht. 90:249-259.

Miscellaneous

Bailey, L. D. 1983. Manitoba Soil Fertility Advisory Committee. 1983 Nitrogen fertilization in crop production. Man. Dep. Agric., Agdex 514 (revised).

Chow, P. N. P.; Grant, C. A. 1983. Registered herbicides for weed control in flax in Western Canada, 1983. Canadex (Weed control, flax) 641.148. pp. 1-2.

Cliplef, R. L. 1983. Consumer acceptance of boar products. Canadex, Pork 441.84, October 1983.

Research Station
Morden, Manitoba

PROFESSIONAL STAFF

D. K. McBeath, B.S.A., M.Sc., Ph.D.	Director
H. G. Brodie	Administrative Officer
M. P. Reimer	Information Officer

Field Crops

G. H. Friesen, B.S.A., M.Sc., Ph.D.	Head of Section; Weed science
S. T. Ali-Khan,[1] B.S.A., M.Sc., Ph.D.	Breeding of field peas
C. G. Campbell, B.S.A., M.Sc., Ph.D.	Breeding of buckwheat
J. Giesbrecht, B.S.A., M.Sc., Ph.D.	Breeding of grain corn
G. H. Gubbels, B.S.A., M.S.A., Ph.D.	Crop management, physiology
F. A. Kiehn, B.S.A., M.Sc.	New crops
R. C. Zimmer, B.Sc., Ph.D.	Diseases of field peas

Horticultural Crops

B. B. Chubey, B.S.A., M.Sc., Ph.D.	Head of Section; Vegetable crops
L. M. Collicutt, B.S.A., M.Sc.	Breeding of ornamentals
G. Mazza, B.S.A., M.Sc., Ph.D.	Food science and technology
D. A. Wall, B.S.A., M.Sc.	Weed control

Oilseed Crops

E. O. Kenaschuk, B.S.A., M.Sc., Ph.D.	Head of Section; Breeding of flax
W. Dedio, B.Sc., M.Sc., Ph.D.	Breeding of sunflower
J. A. Hoes, B.S.A., M.S.A., Ph.D.	Pathology of flax and sunflower
K. P. Minogue, B.Sc., M.Sc., Ph.D.	Pathology of sunflower

Graduate student

M. M. SHAMAILA, B.A.S.	Post-harvest technology

---

[1] Seconded to Canadian International Development Agency Barani Agricultural Research and Development Project, Pakistan, 18 October 1982–.

INTRODUCTION

The programs of the Morden Research Station are directed toward the development of new cultivars and the improvement of management practices for buckwheat, field corn, field peas, pulses, new crops, flax, sunflowers, potatoes, vegetables, and herbaceous and woody ornamentals. This report summarizes some of the results obtained from research conducted during 1983.

Optimum conditions for dehulling and for storage of buckwheat were determined. Two lines of lathyrus with low levels of lathyrogenic compounds were identified. A better understanding was obtained of the principles of drying food crops such as Jerusalem artichoke and carrot. The occurrence and distribution of postseedling rust resistance among flax cultivars were determined. A new method was developed for storage of spores of the downy mildew pathogen of sunflowers. New knowledge was obtained about the chemical changes occurring during respiration of potatoes in storage. Several successful herbicide treatments were identified for control of weeds in a wide range of crops.

Further information on any of these research activities, reprints of publications listed in this report, and copies of previous reports may be obtained from the Research Station, Research Branch, Agriculture Canada, P.O. Box 3001, Morden, Man. R0G 1J0.

D. K. McBeath
Director

FIELD CROPS

Buckwheat

Breeding. Six lines with red pericarps have been developed and will be used in inheritance studies. One line with semidwarf plant habit was advanced to the buckwheat cooperative trials.

Management. Two-row windbreaks of corn were grown adjacent to buckwheat to determine their effects on buckwheat yield and some agronomic characteristics. Yield of Pennquad was improved by the protective influence of the windbreak in each of the 3 yr it was tested, possibly because of a reduction in seed shattering. Yield of Tokyo was improved in 1 out of 3 yr. In 1 yr of testing, Mancan showed no improvement when protected by windbreaks. It was concluded that two-row corn windbreaks may improve buckwheat yields under certain environmental conditions, but the benefits were not large enough nor consistent enough to warrant the extra cost and inconvenience of providing this protection.

Utilization and quality. Dehulling and moisture sorption characteristics of three buckwheat cultivars were determined at water activities ranging from 0.11 to 0.98 and at 1, 10, 25, and 40°C. The recovery of groats after dehulling varied among cultivars, water activities, and temperature of the seeds. Of the three cultivars investigated, Mancan yielded the most amount of groats, whereas CM 169 yielded the least. The dehulling yield of each cultivar decreased as the water activity of the seed increased, but it tended to increase as the temperature was lowered. The amount of whole groats in the milled fraction was essentially constant at water activities of 0.11–0.50 but more than doubled as the water activity was increased from 0.50 to 0.98. Optimum water activity for minimizing degradation of buckwheat seeds during storage and for maximizing dehulling yield and percentage of whole groats was found to be about 0.18.

Field corn

Breeding. Severe drought combined with abnormally high temperatures during July and August resulted in a high degree of seed abortion in the breeding nursery. Those plants that produced good ears under these conditions are assumed to have high drought tolerance. Differences between families were obvious.

Corn borer infestation was at the highest level ever observed in Manitoba. Most of the plants examined contained 10–15 borers each. The combination of these borers and the drought resulted in a high incidence of stalk rot. After two wind storms in early September a major portion of the nursery was broken down, the result of having been weakened by one or both of these factors. The survivors in the nursery did not show much stalk rot and despite heavy corn borer infestation did not break down. The outer rind appears to be strong enough to prevent breakage.

Weed control. Selective control of wild oats was obtained with flamprop-methyl or WL43423 when applied at the two- to four-leaf stage of corn. Cyanazine plus Bio-Veg or E.V. Crop Oil applied early postemergence resulted in excellent control of broad-leaved weeds, including lamb's-quarters. This treatment should replace atrazine as the standard corn herbicide in Manitoba.

Field peas

Weed control. Excellent control of broad-leaved and grass-type weeds resulted from postemergence applications of BAS 9052 (Poast) plus metribuzin or 2,4-DB. All pea cultivars evaluated in 1983 were tolerant to bentazon.

Quality. The yellow-seeded field pea cultivar Century was grown in the field in a 4-yr study to determine the effect of maturation conditions on cooking quality. Treatments included different seeding dates and cutting of the vines at soil level at different stages of maturity. Separate observations were made on peas from different locations on the vines. The results were related to weather conditions during maturation. Later seeding and cutting of vines before full maturity resulted in lower yields, lower 1000-seed weights, and poorer cooking quality. Pod location at the top of the plant, abnormally warm, sunny weather during seed maturation, and abnormally cool, cloudy weather with severe mildew infection during seed maturation also were associated with lower 1000-seed weights and poorer cooking quality.

Lentils

Management. Early seeding of lentils (15 May) yielded 30–50% higher than later plantings (1 June). Row spacings did not affect seed yields significantly but high plant populations per unit area (at a seeding rate of 65 kg/ha) produced a yield increase over lower seeding rates.

Weed control. Excellent broad-spectrum weed control resulted from postemergence applications of metribuzin plus BAS 9052 (Poast) or DPX Y6202. Preplant-incorporated applications of trifluralin plus metribuzin were equally effective.

New crops

Lathyrus. Nc86-2, a line of *Lathyrus cicera*, and Nc8a-74-214, a line of *Lathyrus sativus*, were identified to contain low levels of lathyrogenic constituents. Both lines have shown good agronomic potential.

Utilization of Jerusalem artichoke. Moisture sorption properties and drying behavior of Jerusalem artichoke roots were investigated. Sorption isotherms of dehydrated and freeze dried material, water insoluble components, fructose, glucose, and sucrose were determined at 10, 25, and/or 40°C. Adsorption–desorption isotherms indicated a combination of sorption by soluble sugars in the crystalline, amorphous, and aqueous solution state, and sorption by polymeric material such as cellulose, inulin, and protein. In drying experiments conducted at 50, 65, 80, and 95°C, and also at 65°C and four air velocities and four bed depths, it was found that temperature and drier load conditions are of critical importance to drying behavior, drying time, and finished product color. Increasing the air velocity from 2.0 to 4.2 m/s, at a temperature of 65°C and a bed depth of 10.5 cm, did not change the rate for drying roots cut into 1-cm^3 pieces.

Weed control. Preplant-incorporated treatments of trifluralin, EPTC, and chloramben were selective for the control of annual broad-leaved weeds in Jerusalem artichoke. Herbicide mixtures containing dicamba, 2,4-D, and 3,6-dichloropicolinic acid gave effective postemergence control of volunteer Jerusalem artichoke in barley. Dill continued to exhibit satisfactory tolerance to preplant-incorporated applications of trifluralin, ethalfluralin, EPTC, and chloramben and postemergence applications of sethoxydim and HOE 00736.

OILSEED CROPS

Flax

Disease. When inoculated at the prebloom stage, the level of postseedling rust resistance (PSRR) to exotic race 22 appeared to be high in the varieties Noralta and NorMan, and intermediate in Norland, whereas the variety

Summit lacked PSRR and was highly susceptible. A similar study with exotic race 79 indicated a high or very high level of PSRR in the varieties Culbert, Dufferin, Linott, McGregor, Natasja, Noralta, Norland, NorLin, and NorMan. In contrast, PSRR to race 79 occurred at intermediate and very low levels in Redwood 65 and Bison, respectively. Data on varietal PSRR are valuable because this gives an indication of the ability of each variety to escape yield reductions when new virulent rust races appear.

Management. In the 1st yr of a 3-yr study, flax yields tended to be lower on canola stubble than on barley stubble, possibly due to a toxic principle. In the 2nd yr, flax yields were much lower after canola than after barley. However, part of this could be due to a difference in plant stands because of crusting. In the 3rd yr there was no reduction in yield on canola stubble, possibly because spring moisture conditions were better and growing temperatures were lower than in the previous 2 yr.

Weed control. An ultra-low rate of chlorsulfuron (Glean), 3 g/ha, with Agral 90 at 0.1% and applied early postemergence, was effective on annual broad-leaved weeds. DPX Y6202 was effective on wild oats when applied at early growth stages. The performance of a premixed formulation of diclofop-methyl plus bromoxynil (designated as Hoegrass II) was found to be as effective as tank-mixing these herbicides.

Sunflowers

Breeding. One hybrid, Morden 12, was supported for licensing by the Expert Committee on Grain Breeding. This hybrid has high oil content and matures about 6 days earlier than most commercial hybrids. It has been released for increase and distribution.

The sunflower midge has become a serious pest in the Red River valley. A number of hybrids and lines were screened for midge resistance. Although no hybrid escaped damage completely, some were less affected than others. Delayed seeding resulted in lower infestations.

Disease. A new method for preserving and storing spores of downy mildew (*Plasmopara halstedii*) was developed. Spore-bearing sunflower leaves are air dried and stored in airtight vials at –25°C. Pathogenicity remains undiminished for more than 12 mo. The technique is simple, permits long-term storage, and saves labor and greenhouse space.

Weed control. Desmedipham, bifenox, and R-40244 selectively controlled wild mustard in sunflowers. Crop tolerance was more acceptable at the two-leaf stage than at the four-leaf stage. R-40244, tank-mixed with trifluralin or EPTC and applied preplant-incorporated, resulted in excellent control of both broad-leaved and grass-type weeds.

Soybeans

Weed control. Bentazon, tank-mixed with HOE 00736, DPX Y6202, Dowco 453, or CGA 82725, and applied postemergence, resulted in almost total weed control in soybeans.

HORTICULTURAL CROPS

Ornamentals

Breeding and evaluation. New accessions acquired for evaluation under prairie conditions numbered 110 herbaceous and 45 woody plants. The Morden cultivars of chrysanthemums were evaluated as potted plants but were found to be unsuitable due to weak stems, poor plant habit, and uneven flowering.

Potatoes

Utilization and quality. Carbon dioxide evolution, chip color, and sucrose, reducing sugars and dry matter contents of Norchip and Russet Burbank potatoes of various ages and degrees of bruising were determined. It was found that CO_2 evolution increased to a high value 15–16 h after harvest and declined to an equilibrium level after about 40 h. The amount of CO_2 released by mature potatoes was lower than that released by immature tubers. Bruised tubers respired at a higher rate than intact tubers and the rate of respiration increased with the severity of bruising. Reducing sugars and sucrose content of immature potatoes were higher than those of mature tubers, but chip color and starch content improved with maturity.

Weed control. Weed control studies in potatoes yielded the following significant results: grass-specific herbicides sethoxydim, Dowco 453, HOE 00736, CGA 82725, and DPX Y6202 gave excellent control of green foxtail at manufacturers' recommended rates. Several new broad-spectrum herbicides, R 40244, PPG 844, PPG 1013, and SD 95481, applied preemergence were found to be selective in potatoes.

Vegetables

Utilization and quality. The effect of blanching, sulfiting, starching, freezing, and dipping in sucrose and sodium chloride prior to air drying on color of dehydrated carrot cubes was investigated. Losses in carotene content as a result of pre-drying and drying operations ranged from 43% for untreated carrots to 18% for blanched, sulfited, and starch-dipped samples. Drying air temperature had little effect on color retention. Diced carrots that were blanched and sulfited and then dried in the vibro fluidizer at 50°C contained 74 to 82 mg of β-carotene per 100 g of dry matter, whereas the same carrots dried at 35, 65, and 100°C contained 63, 76, and 73 mg of β-carotene, respectively. Diced carrots that were blanched for 3 min, and then dipped into 1% sodium bisulfite solution and into 2.5% corn starch suspension at 80°C prior to drying had the best color and were the most stable at room temperature.

An engineering analysis of the vibro fluidizer was also carried out by considering that the carrots in the equipment behaved as in a well-mixed packed bed. From the basic equations developed and the knowledge of the desorption isotherms of the material undergoing drying, it was possible to model the drying of carrot cubes in this type of equipment with good engineering reliability.

Weed control. Several new grass-specific herbicides including sethoxydim, fluazifop-butyl, Dowco 453, CGA 82725, and HOE 00736 were found to be very selective in carrots and broccoli at the manufacturers' suggested rates. Carrots also exhibited good tolerance to preemergence applications of R 40244 and postemergence applications of DPX Y6202. Garlic exhibited satisfactory tolerance to allidochlor plus chlorpropham, propachlor, and oxyfluorfen to warrant further evaluation.

PUBLICATIONS

Research

Campbell, C. G. 1983. Manor buckwheat. Can. J. Plant Sci. 63:1053-1054.

Campbell, C. G.; Ali-Khan, S. T. 1983. Mancan buckwheat. Can. J. Plant Sci. 63:1055-1056.

Chong, J.; Ali-Khan, S. T.; Chubey, B. B.; Gubbels, G. H. 1983. Energy dispersive x-ray analysis of field peas with different cooking quality. Can. J. Plant Sci. 63:1071-1074.

Chubey, B. B.; Dorrell, D. G. 1983. The effect of fall and spring harvesting on the sugar content of Jerusalem artichoke. Can. J. Plant Sci. 63:1111-1113.

Chubey, B. B.; Mazza, G. 1983. A non-destructive method for rapid evaluation of boiling quality of potato tubers. Am. Potato J. 60:693-698.

Dedio, W.; Hoes, J. A. 1983. Registration of sunflower restorer parental lines CM 586 and CM 587. Crop Sci. 23:196.

Dedio, W.; Hoes, J. A.; Huang, H. C. 1983. Registration of sunflower restorer lines CM 338 and CM 361. Crop Sci. 23:195.

Friesen, G. H.; Korwar, G. R. 1983. A decade of weed research in the Indo-Canadian Dryland Project. Weed Res. 23(6):365-371.

Marshall, H. H.; Campbell, C. G.; Collicutt, L. M. 1983. Breeding for anthocyanin colors in *Rosa*. Euphytica 32:205-216.

Mazza, G. 1983. Dehydration of carrots: Effect of predrying treatments on moisture transport and product quality. J. Food Technol. 18:113-123.

Mazza, G. 1983. Correlations between quality parameters of potatoes during growth and long-term storage. Am. Potato J. 60:145-149.

Mazza, G. 1983. A comparison of methods of analysis for sugars in potato tubers. Can. Inst. Food Sci. Technol. J. 16:234-236.

Mazza, G.; Hung, J.; Dench, M. J. 1983. Processing/nutritional quality changes in potato tubers during growth and long-term storage. Can. Inst. Food Sci. Technol. J. 16(1):39-44.

Miscellaneous

Collicutt, L. M.; Marshall, H. H. 1983. The parkland roses. Canadex 276.35.

Gubbels, G. H.; Campbell, C. G. 1983. Optimum swathing time for buckwheat. Canadex 118.50.

Gubbels, G. H.; Dedio, W. 1983. Diquat as a desiccant for sunflower. Canadex 145.55.

Gubbels, G. H.; Dedio, W. 1983. Yield and quality reductions in sunflower after simulated frost. Canadex 145.56.

Harp, H. F.; Collicutt, L. M. 1983. Lythrums for home gardens/Les lythrums pour le jardin familial. Agric. Can. Publ. 1285 (revised). 3 pp.

Research Station
Winnipeg, Manitoba

PROFESSIONAL STAFF

T. G. Atkinson,[1] B.S.A., M.Sc., Ph.D.	Director
M. D. Hamilton	Administrative Officer

Scientific Support

G. F. Atkinson, B.S.A., M.Sc., Ph.D.	Biometrician
S. Bishop,[2] B.A., M.L.S.	Library Coordinator, Manitoba and Saskatchewan
J. L. Buth, B.Sc., M.Sc.	Technical Information Officer
M. Malyk,[2] B.Sc., M.Sc., M.L.S.	Librarian
S. M. Woods, B.Sc., M.Sc., Ph.D.	Programmer/Analyst

Cereal Breeding

D. Leisle, B.S.A., M.Sc., Ph.D.	Head of Section; Durum wheat breeding
V. M. Bendelow, B.Sc., M.Sc., Ph.D.	Cereal chemistry
D. Brown, B.S.A., M.Sc.	Oat breeding
A. B. Campbell, B.S.A., M.Sc., Ph.D.	Common wheat breeding
E. M. Czarnecki, B.S.A., M.Sc.	Common wheat breeding
P. L. Dyck, B.S.A., M.Sc., Ph.D.	Wheat genetics
E. R. Kerber, B.S.A., M.Sc., Ph.D.	Wheat cytogenetics
M. I. P. Kovacs, B.Sc., M.Sc., Ph.D.	Cereal chemistry
O. M. Lukow, B.Sc., M.Sc., Ph.D.	Cereal chemistry
D. R. Metcalfe, B.S.A., M.Sc., Ph.D.	Barley breeding and genetics
R. I. H. McKenzie, B.S.A., M.Sc., Ph.D.	Oat breeding and genetics
J. S. Noll, B.Sc., Ph.D.	Physiology

Cereal Diseases

R. Rohringer, Dr.sc.agr.	Head of Section; Molecular biology of cereal rusts
J. Chong,[3] B.Sc., M.Sc., Ph.D.	Oat crown rust

C. C. GILL, B.Sc., Ph.D.	Viruses
S. M. HABER,[4] B.Sc., M.Sc., Ph.D.	Viruses
D. E. HARDER, B.Sc., M.Sc., Ph.D.	Oat stem rust
N. K. HOWES, B.Sc., Ph.D.	Molecular biology
W. K. KIM, B.Sc., M.Sc., Ph.D.	Molecular biology of cereal rusts
J. W. MARTENS, B.Sc., Ph.D.	Wheat stem rust
J. J. NIELSEN, Dr.sc.agr.	Smuts
D. J. SAMBORSKI, B.S.A., M.Sc., Ph.D.	Wheat leaf rust
A. TEKAUZ, B.Sc., M.Sc., Ph.D.	Leaf diseases
P. L. THOMAS, B.S.A., M.Sc., Ph.D.	Microbial genetics, smuts

Stored Products

S. R. LOSCHIAVO, B.Sc., M.Sc., Ph.D.	Head of Section; Stored grain insect biology
D. ABRAMSON, B.Sc., M.Sc., Ph.D.	Mycotoxicology
P. S. BARKER, I.A., M.Sc., Ph.D.	Biology and control of stored grain pests
J. T. MILLS, B.Sc., Ph.D., D.I.C.	Development and control of storage molds
R. N. SINHA, B.Sc., Ph.D.	Ecology of granary insects, mites, and fungi
L. B. SMITH, B.Sc., M.S.A., Ph.D.	Ecology of stored product insects
N. D. G. WHITE, B.Sc. (Agr.), M.Sc., Ph.D.	Biology and control of stored product insects

Integrated Pest Control

W. J. TURNOCK,[5] B.S.A., M.Sc., Ph.D.	Head of Section; Ecology and population dynamics
G. L. AYRE, B.S.A., M.S.A.	Insect ecology
R. P. BODNARYK, B.A., M.Sc., Ph.D.	Biochemistry and toxicology
G. K. BRACKEN, B.Sc., M.Sc., Ph.D.	Physiology and behavior
G. H. GERBER, B.S.A., Ph.D.	Histology, physiology, and behavior
B. M. HEGDEKAR, B.Sc., M.Sc., Ph.D.	Diapause and cold hardiness
R. J. LAMB, B.Sc., M.Sc., Ph.D.	Systems biology
O. N. MORRIS, B.Sc., M.Sc., Ph.D.	Insect pathology
W. ROMANOW, B.S.A., M.Sc.	Insect surveys and control
H. G. WYLIE, B.A., Ph.D.	Host–parasite relations

Departure

D. G. DORRELL, B.Sc., M.Sc., Ph.D. Transferred to Lethbridge Research Station 15 August 1983	Director

VISITING SCIENTISTS

D. W. Holden, B.Sc., Ph.D. Natural Sciences and Engineering Research Council	Molecular biology of cereal rusts
Shang, Hongsheng M.Sc.	Wheat rusts
Hui-Gen, Huang B.S.A. From October 1981 to October 1983	Pathology of smut fungi
O. Imura, B.Sc. From October 1982 to October 1983	Population ecology of stored product insects

Graduate students

C. Aitchison, B.Sc., M.Sc.	Entomology
P. P. Claude, B.Sc.	Genetics in wheat
B. Gabor, B.S.A.	Plant diseases
M. Howlader, B.Sc., M.Sc.	Entomology
W. Legge, B.S.A.	Durum wheat research
G. Maiteki, B.Sc.	Entomology
G. Penner, B.S.A.	Cytogenetics in wheat
A. Plourde, B.Sc.	Plant breeding
M. Trottier, B.Sc.	Entomology

---

[1] Appointed 15 August 1983.
[2] Seconded from Libraries Division, Finance and Administration Branch.
[3] Appointed 12 January 1983.
[4] Appointed 5 September 1983.
[5] On a transfer of work to Imperial College, Slough, England, August 1983–July 1984.

INTRODUCTION

Research programs at the Winnipeg Research Station focus on three main areas of responsibility: the development of improved cultivars of cereals specifically adapted to the eastern prairies, research on the protection of stored cereals, oilseeds, and their products, and research on the integrated control of insect pests of field crops other than cereals. In each of these areas, interdisciplinary teams of scientists are pursuing both mission-oriented and basic research.

Improvements of cereal cultivars, historically the objective of the original Dominion Rust Research Laboratory established in 1925, requires the close collaboration of plant breeders, geneticists, cytogeneticists, plant pathologists, and cereal chemists. In recognition of the long and distinguished success of the station's bread wheat research team, its members were honored by the Professional Institute of the Public Service of Canada and by the Honourable Eugene Whelan, Minister of Agriculture. The continuing need for such ongoing research was dramatically emphasized in 1983 by the appearance of rust inoculum unprecedented since the 1954 outbreak but to which currently recommended cultivars were resistant.

Research on the storage and protection of cereals, oilseeds, and their products is national in scope and involves close cooperation with the Plant Health and Plant Products Directorate, the Canadian Grain Commission, and the grain industry. Particular emphasis is being placed on the ecology of organisms infesting stored grain, chemical and physical measures to control infestations, and the microbiological and environmental factors determining the occurrence of mycotoxins as well as the methodology of their detection.

Research on the integrated control of field crop insects on cereals, and particularly those that attack canola and the various "special crops" grown in southern Manitoba, includes the biology and ecology of pest species, the evaluation of biological and chemical control measures, the assessment of economic damage, and the development of management systems.

During 1983, our scientists collaborated with four visiting scientists from the People's Republic of China (two), England, and Japan, and supervised nine graduate students from the University of Manitoba. Dr. D. G. Dorrell, Director since 1980, was transferred in August to become director of the Lethbridge Research Station, and in September, Dr. S. M. Haber was recruited as cereal virologist.

The following report is a brief summary of research carried out in 1983. Further information or reprints of this report or of the listed publications can be obtained by writing to individual scientists or to the Research Station, Research Branch, Agriculture Canada, 195 Dafoe Road, Winnipeg, Man. R3T 2M9.

T. G. Atkinson
Director

BREEDING, GENETICS, AND CYTOGENETICS

Breeding programs for common wheat, durum wheat, barley, and oats emphasize production of high-yielding cultivars with improved agronomic characteristics and resistance to rusts, smuts, and other cereal diseases. Good quality is a primary objective, involving milling and baking characteristics in common wheat, semolina quality in durum wheat, malting quality in barley, and feeding quality in wheat, oats, and barley.

Barley

The recently released two-row cultivar Norbert occupied 6.6% of the total Manitoba barley area in 1983, accounting for approximately 50% of the area seeded to two-row cultivars. Norbert is receiving further evaluation by the malting and brewing industry in plant-scale trials. A two-row selection, TR212, received support for licensing and is undergoing increase and advanced tests for final malting and brewing acceptability. In addition to good disease resistance, this selection has unique enzyme systems that permit it to be malted in less time than current cultivars. Two-row selections entering early stages of yield testing incorporate various combinations of the *Un8* gene for resistance to loose smut, the *Yd*^{2} gene for resistance to barley yellow dwarf virus, and the "Concord" system for post-harvest dormancy, as well as good resistance to stem rust and net blotch. These disease resistance traits are also being incorporated into the six-row cultivar Argyle. In the program to improve lysine content, two-row lines possessing high lysine in combination with good agronomic traits have been developed, and are being subjected to feeding trials.

Low hordein content, a potentially desirable brewing quality characteristic, was successfully incorporated into both blue- and white-aleurone barleys. However, malting data indicated that selections possessing low hordein content are too low in diastatic power to be of interest to the malting and brewing industry. A procedure for the chemical determination of the viscous principle in malt extract was developed; beta-glucans are precipitated with ammonium sulfate, followed by hydrolysis to glucose, which is measured on an autoanalyzer. The procedure is being used in advanced quality screening tests.

Common wheat

The recently released new cultivars Benito and Columbus occupied a total of 35% and 13.8% of bread wheat hectarage in 1983 in Manitoba and Saskatchewan, respectively. These cultivars provide improved leaf rust resistance and harvesttime sprouting resistance, respectively. The cultivar Katepwa, licensed in 1981, has performed well in Manitoba trials with a 3-yr average yield of 108% of Neepawa. Commercial seed will be available for 1984 planting.

Good sprouting resistance has been transferred to the utility cultivar Glenlea from RL4137 through backcrossing. Nine promising backcross lines are being further evaluated. Transfer of sprouting resistance to the sawfly-resistant cultivar Chester in a similar program was not achieved. Field and rain simulator tests have confirmed that a line from the cross Kenya Farmer/Kenya 321.BT.1.B.1 has the best sprouting resistance of known white-seeded cultivars. It is being used extensively in breeding programs for white-seeded wheats. A study of the role of lipids in sprouting resistance indicated that the sprouting resistant cultivar Columbus and line RL4137 had lower total and polar lipid contents than Neepawa. Columbus resembled its dormant parent, RL4137, in the level of some nonpolar lipids and fatty acid constituents.

Backcrossing has been initiated to transfer resistance to loose smut, leaf rust, and sprouting into the potential "triple M" quality cultivar, HY320.

The *Sr35* gene for stem rust resistance from *Triticum monococcum* was located on chromosome 3AL, and subsequently transferred to tetraploid and hexaploid wheats. It confers an equally high level of resistance at all three ploidy levels. Other genes of interspecific origin that have been backcrossed into good agronomic type are *Lr28*, *Lr29*, and *Lr34*.

Six strains of *Aegilops squarrosa* were studied, using chromosome substitution lines, for possible presence of a non-suppressor allele to the suppressor gene for stem rust resistance carried on chromosome 7DL of Canthatch. The results indicate that all six strains have the suppressor possessed by Canthatch.

A study of temperature sensitivity of leaf rust genes showed widely differing interactions. Lines with genes *Lr16*, *Lr17*, and *Lr23* became more resistant at higher temperatures, whereas some lines became less resistant; the line with *Lr18* was susceptible at 25°C. Lines with other genes were temperature stable with some leaf rust isolates and unstable with other isolates.

Durum wheat

The cultivar Coulter, licensed in 1977, occupied 55% of the durum wheat area of Manitoba, and 17% of that in the eastern portion of Saskatchewan. In advanced tests, low protein content is a continuing problem with high-yielding lines.

Two sources of post-harvest dormancy are being explored in the durum wheat program. These are a durum wheat line, D7075, and a white-grained hexaploid wheat line from the cross Kenya Farmer/Kenya 321.BT.1.B.1. Field-grown F$_4$ lines of crosses involving these lines showed improved levels of dormancy over the durum wheat checks.

An instrument was developed and tested to permit the evaluation of pasta cooking quality on small samples of durum wheat. It provides an objective evaluation of compressibility and recovery, using small discs of cooked pasta.

Oats

Producer acceptance of the rust resistant cultivar Fidler, licensed in 1980, has been rapid in the traditional rust area; 59% of the 1983 Manitoba oat hectarage was devoted to this cultivar. Commercial seed of the more recently licensed cultivar, Dumont, will be available for 1984 planting. Dumont will provide further rust resistance and a large, plump kernel desired by producers.

The feasibility and desirability of oats having a tan-colored hull was further explored. A tan-colored oat with lower hull content, O.T.224, was increased for market evaluation by the Canadian Wheat Board. The genetics and relationship of tan hull to oat quality are also being studied. Another tan-colored oat, O.T.216, was retained in the cooperative oat test. It has stiff straw, high yield, good resistance to rust and smut, and some tolerance to barley yellow dwarf virus.

New and different genes for rust resistance continue to be incorporated into the breeding program to provide a broad base of resistance. Two lines with the leaf rust resistance genes *PC-55* and *PC-56* have reached an advanced testing stage. In a genetic study of leaf rust resistance of three wild *Avena sterilis* lines, five new genes for resistance were identified; two of these genes provide highly useful resistance. Crosses with 11 additional wild oats from the Iberian Oat Collection are being used for genetic studies.

CEREAL DISEASES

Pathology research is multifaceted and plays an integral part in the breeding of all cereal cultivars. Annual disease surveys are conducted to determine the prevalence of races of rusts and smuts; new genes for resistance to various diseases are identified and transferred to desirable germ plasm; breeders' lines are evaluated for resistance; basic studies are conducted on the biology, genetics, histochemistry, and ultrastructure of the pathogens; and long-term research is under way to explain the mechanism of host–parasite interactions and the molecular basis of resistance.

Rust surveys

Stem rust of wheat. The natural stem rust epidemic potential was assessed by means of special nurseries and field surveys. Susceptible cultivars in Manitoba and Saskatchewan had infection levels of 20–60% by late August. Three hundred and twenty-seven field and nursery isolates of rust were characterized using 16 differential lines. Twelve different virulence combinations were found with race C53, predominant since 1977, comprising over 95% of the isolates in the eastern prairies. Races C4 and C88 were the most common in Alberta, where there was much more variability than in Manitoba and Saskatchewan. None of the races identified threaten commercial cultivars or advanced breeding lines.

Leaf rust of wheat. The identification of races from leaf rust survey samples was carried out with 20 differential lines, each with a single gene for resistance. Lines with resistance genes *Lr16*, *Lr19*, and *Lr21*, and line T^6xP.I.58548 were resistant to all survey samples. None of the isolates from Manitoba and Saskatchewan were virulent on the cultivars Columbus and adult plants of the cultivar Benito. Also resistant were the cultivars Sinton and Glenlea, as well as all recommended durum cultivars. However, the cultivar Neepawa was susceptible to leaf rust in 1983. Forty-six virulence combinations were identified using 16 genes for resistance. However, 23 combinations were only isolated once in the 1982 survey and four combinations comprised 72% of survey isolates.

Oat crown rust. In Western Canada oat crown rust was first observed in mid-July, and became widespread by mid-August throughout the rust area. Late-sown fields of susceptible cultivars in Manitoba sustained heavy damage by crown rust. The new cultivar Fidler, which comprised about 59% of the oats grown in Manitoba, was highly effective in controlling the disease.

Oat stem rust. This rust was first observed during the 2nd wk of July. The disease became widespread throughout Manitoba and eastern Saskatchewan by mid-August, but the most severe infections occurred in late-sown fields of susceptible cultivars in southeastern Manitoba and the interlake region. The cultivar Fidler effectively controlled stem rust. Preliminary tests indicate that NA27 was the predominant race in Western Canada, and NA25 was the predominant one in Eastern Canada.

Molecular biology of cereal rust diseases

Efforts were continued to detect and isolate the products of the genes for resistance and of the genes for avirulence. Detergent-soluble polypeptides from uredospores of oat stem rust were detected and compared with those from wheat stem rust. Of the approximate 300 polypeptides from each of nine races of oat stem rust, 22 varied between races. Some races had identical electrophoretic patterns, and some differed by 4–16 polypeptides. A group of polypeptides was associated with avirulence on hosts with resistance genes *Pg9* or *Pg15*. Thirty-four polypeptides differed between oat and wheat stem rusts. Four polypeptides were identified as species markers. Several polypeptides that varied between 18 races of wheat stem rust were correlated with the presence of certain virulence genes. Two prominent polypeptides prepared from wheat stem rust uredospores were partially purified. Neither of these polypeptides bound to lectin conA, indicating that they are not glycoproteins.

Further studies were conducted on the protein composition of intercellular washing fluid (IWF) from rust-infected wheat leaves, because this liquid may be a potential source of the products of the genes for avirulence. Several classes of IWF proteins were identified on cellulose nitrate blots from isoelectric focusing/polyacrylamide gel electrophoresis: peroxidases, esterases, glycosidases, phosphatases, and glycoproteins. IWF from infected leaves contained at least 30 more conA-binding glycoproteins than that from noninfected leaves. For the detection of other glycoproteins a new method was developed involving biotinylated lectins and peroxidase coupled to avidin.

Smuts

Loose smut of wheat was found in 36% of the fields surveyed in Manitoba and Saskatchewan. Infection ranged up to 4%, with a mean of 0.08%, the lowest in 5 yr. Smut of oats was found in 30% of the fields, with infection up to 0.5%, and a mean of 0.05%. Two new races (tentatively designated as T38 and T39) were identified in field collections of *U. tritici* from Israel and the eastern USA. T39 has very wide virulence, and its possible virulence on commercial cultivars of Western Canada will be tested in isolation. Of 157 fields of barley surveyed, 87% contained smutted plants, with an average of 0.9% loose, 0.1% false loose, and 0.1% covered smut. Two new sources of resistance to loose smut in barley were identified in introductions from Ethiopia.

The smuts pathogenic on either barley or oats were hybridized on an *Agropyron* sp. as common host: *U. nigra* × *U. avenae*, *U. nigra* × *U. kolleri*, *U. hordei* × *U. avenae*, *U. hordei* × *U. kolleri*. The echinulate *U. nigra* had the genotype EIE2 for spore wall morphology; *U. hordei* had Ele2, whereas the also smooth *U. kolleri* had ele2, elE2, or Ele2, depending on geographic origin. Hybrids between certain genotypes of the smooth *U. hordei* and *U. kolleri* gave echinulate offspring.

A chemotaxonomic study was conducted with respect to the polypeptides in races and species of several cereal smuts. The technique proved unsuitable to differentiate between races of *Ustilago* spp., but gave strong evidence to support the concept of separate species for the loose smuts of wheat and barley, and that of uniting the four seedling-infecting species on barley and oats under one species, *U. segetum*.

Foliage diseases

The evaluation of 1200 F_4 barley lines from three crosses involving a spot blotch tolerant line, N.D. 4758-1, and net blotch resistant lines, was completed. No tolerance/resistance to spot blotch was found, but resistance to net blotch was present in about one-half of the lines.

A trial to assess yield loss caused by barley leaf stripe was conducted. Leaf stripe developed at levels of 43, 32, 19, 9, and 0.5% average, but significant grain loss of 12% occurred only in the highly infected plots. The efficacy of seed treatments to control leaf stripe was tested. Check plots developed 25% leaf stripe. Percent effectiveness of the 10 compounds used ranged from 5% for Polyram to 100% for Baytan and RH5781F. Surveys for leaf stripe incidence in south central Manitoba showed that the incidence of this disease has decreased (1981—24%, 1982—13%, 1983—4%).

Field trials on efficacy of foliar protective fungicides to control leaf diseases of Norstar winter wheat were carried out at two locations in Manitoba. At one of them, where stem rust was the predominant disease, a 63% increase in yield was obtained and at the other, where tan spot/septoria nodorum blotch were predominant, a 27% yield increase resulted after two applications of mancozeb.

Virus

Barley yellow dwarf virus (BYDV) occurred sporadically wherever crops were seeded late, south of the Trans-Canada Highway, and east of a line running from Austin to Morris. Crops farther west showed little or no damage from the disease. There were only traces of damage on wheat and barley from aster yellows.

Twenty isolates were sampled from the field to determine which BYDV strains were prevalent in 1983. Most isolates were of the virulent aphid-nonspecific strain. *Rhopalosiphum padi* was the most important aphid vector. An aphid-nonspecific isolate of BYDV was found to be unstable after purification. Another similar isolate (7601) gave very high yields of the virus, and the virus was reasonably stable. Antisera prepared from this and four other strains will be used for evaluating the usefulness of the enzyme-linked immunosorbent assay (ELISA) for detection of BYDV in the field.

STORED PRODUCTS PROTECTION

Research on the biology and control of pests in stored cereals and oilseeds emphasizes the interaction of insects and microorganisms in a dynamic storage environment. The program includes the following: studies of the ecology of stored grain; factors that limit long-term storage; identification and quantification of insects in stored products; influence of attractants and feeding stimuli on insect behavior; control of insects and mites by environmental, physical, and chemical means; and identification and control of mycotoxins in stored grain and oilseeds.

Storage ecology

The keeping quality of wheat and wheat-plus-dockage, which was infested by two stored-product beetles, the sawtoothed grain beetle, *Oryzaephilus surinamensis* (Linnaeus), and the rusty grain beetle, *Cryptolestes ferrugineus* (Stephens), at 30°C and 70% relative humidity (RH) was determined over a 20-wk period. The quality assessment criteria used were the changes in fat acidity values, seed germination, germ and endosperm damage, and fungal and bacterial infection. Heavy infestation (650–800 adults per 130 g) by both insect species in wheat-plus-dockage treatment resulted in significantly higher levels of infection by *Penicillium* and bacteria, which led to greater loss in seed germination than in noninfested wheat-plus-dockage. Fat acidity values in wheat-plus-dockage treatment increased significantly ($P < 0.01$) only when it was infested with the sawtoothed grain beetle, which produced significantly more adults and larvae than the rusty grain beetle. Infestation by insects resulted in a decreased level of seed infection by fungi of the *Aspergillus glaucus* group.

Movement and oviposition of two species of stored-product moth, *Ephestia cautella* (Walker) and *Plodia interpunctella* (Hübner), were studied under natural day–night cycles for 4-day periods, through four seasons and under continuous darkness (DD) and continuous light (LL) for one 4-day period. Both sexes of the two moth species showed initial-movement peaks in the early evening in all four seasons. Oviposition peaks corresponded with the movement peaks. The main difference between the two species was that *E. cautella* showed a second-movement peak before dawn but *P. interpunctella* did not. In winter, however, *E. cautella* did not show either a second-movement or an oviposition peak. Under LL and DD conditions, both species, regardless of sex, showed erratic movement and oviposition patterns without any discernible peaks. The response of *P. interpunctella* kept at LL, however, was significantly different ($P < 0.01$) from that obtained under DD conditions. Movement of both species regardless of sex increased with age and their patterns became more irregular.

The first incidence of the stored-product moth, *Haplotinea insectella* (Fabricius) (Lepidoptera: Tineidae), in North America is reported from an infestation of overwintered stored wheat and oats in Winnipeg, Man., in 1981 and 1982. The potential of this species as a pest of stored cereals and oilseed was tested by investigating feeding, diapause, development, and mortality on whole and crushed cereals and oilseeds, as well as on fungi, at 25 ± 1°C and 70 ± 2% RH. Insects fed well and completed egg-to-adult development in 49–57 days on crushed wheat, oats, barley, and triticale. Oats were the most favored cereal diet.

Changes in the quality of frost-damaged canola seeds (*Brassica napus* L. and *B.*

campestris L.) from 60 bins in Manitoba were studied during October 1982–April 1983. Twenty-two quality parameters were assessed on seed samples obtained at two bin depths on four sampling occasions. Generally, quality of seeds in official grades 2CR, 3CR, and "Sample Canada Account damaged because of frost," did not decline during storage. Laboratory studies with jars of frost-damaged seeds stored at 6–12% moisture content (MC) and 5–25°C for 49 days indicated that odor is a more rapid indicator of incipient deterioration than is visible mold. Results from bin and laboratory studies show that storage of frost-affected canola seeds which have been binned dry is influenced primarily by factors associated with seed immaturity rather than by development of spoilage molds.

Mycotoxins

Wheat stored at 15 and 19% MC in a typical farm granary remained mycotoxin-free for the duration of a 60-wk study. In previous laboratory and granary studies, ochratoxin A formed in wheat at 20.5% MC within 4 wk. Approximately 19% may represent a critical moisture limit for mycotoxin formation in granary-stored wheat, given the indigenous mycoflora.

Preliminary reculturing experiments with *Aspergillus versicolor* indicated that a synthetic liquid medium was a better substrate for sterigmatocystin production than was ground barley. Using this medium, six of 10 *A. versicolor* isolates produced this mycotoxin.

Biology

Pheromone-baited traps inserted in infested grain were no more effective than unbaited ones in recovering rusty grain beetles. No rusty grain beetles were found in pheromone-baited traps or unbaited traps suspended in empty grain bins, or in grain residues on the floor and around the bin during the summer of 1983. However, during a 12-wk period from 1 September to 29 November more than 7200 beetles were recovered from four traps inserted 35 cm into wheat in a bin and only two dead beetles in probe samples taken beside the traps. The sources of infestations include grain residues in and around the bin and grain spillage. In summer, infestations spread by windblown beetles or beetles flying in warm weather.

Moisture content of wheat at the roof center openings in 45-t steel granaries near Winnipeg ranged from 9.8 to 12.8% at harvesttime. Twelve wk later it had increased by nearly 3%. Mean temperatures at the same location 1 m below the surface declined from an initial 31.3° to 16.7°C 13 wk later, whereas those at the roof edge opening declined from 29.8° to 7.8°C. Two traps placed in the center location of each of nine granaries on 9 November contained from one to nearly 5000 beetles 1 wk later. All granaries were infested. No beetles were found in traps placed at the edge location. On another farm, more than 15 000 beetles were recovered from one trap in 1 wk.

Laboratory studies were completed on the distribution, survival, and development of four species of stored-product insects on rapeseed and canola cultivars. None of the insects showed preferences for the rapeseed cultivars, Midas, Span, Target, Torch, Tower, Zephyr, or the canola cultivars, Altex, Andor, Candle, Regent, Reston, and Tobin. Most of the newly emerged larvae of the red flour beetle completed development on Tower. Fewer completed development on Midas, Torch, and Zephyr. On all cultivars, most died within 2 mo after emerging as adults. In general, survival and development of the merchant grain beetle, red flour beetle, sawtoothed grain beetle, and rusty grain beetle were higher on canola than on rapeseed. The red flour beetle and the merchant grain beetle could become established on some of the newer canola cultivars if temperature and moisture were suitable.

A lower incidence of rusty grain beetle was found in granaries in Saskatchewan than in Manitoba, possibly because the collections were made too early in southern Saskatchewan. The native American black flour beetle, *Tribolium audax* Halstead, was found on 78% of the farms in Saskatchewan, compared to 62% in Manitoba. Since 1955, the number of major insect pests has not changed in Saskatchewan.

T. audax appears to be at least as cold hardy as the rusty grain beetle, because adults acclimated for 6 wk at 15°C suffered no mortality from 2 wk exposure to −10°C.

Oviposition site selection by the yellow mealworm was studied in the laboratory. The adults are surface dwellers and the females normally enter the foodstuff to oviposit. The distance traveled into the foodstuff was age-related; the females went gradually deeper until the 9th day after eclosion. Physical and chemical factors (i.e., type and quality of foodstuff) and biological factors (i.e., adult density and presence of yellow mealworm eggs and larvae) were assessed when oviposition sites were selected. The females attempted to avoid poor-quality food when selecting oviposition sites, and usually laid fewer eggs and died sooner when poor-quality food was present. As adult density increased, the females went deeper to oviposit. The females also went deeper to oviposit when eggs and larvae were present, but the effects of eggs and larvae were small and there seemed to be threshold densities as far as both factors were concerned.

Control

The flour beetles *Tribolium madens* (Charpentier) and *T. audax* were shown to have similar levels of tolerance to hydrogen phosphide and to carbon disulfide, indicating that practical levels of treatment for control of these species in bulks of grain which are adequate for one species will also be adequate for the other. Adult beetles of both species readily succumbed to phosphine (hydrogen phosphide) gas concentrations that reached 130 ppm in the air inside a mass of grain 24 h after the initiation of fumigation. However, some eggs of both species tolerated phosphine gas concentrations that reached 500 ppm for 2 consecutive days after the initiation of fumigation. Some of the eggs survived phosphine concentrations of 300, 350, and 270 ppm on each of the 3 consecutive days after the start of the fumigation. All eggs were killed with longer exposure periods or higher phosphine gas concentrations.

Adults of *T. audax* and *T. madens* were slightly more tolerant than their eggs to fumigation with carbon disulfide while they were in a bulk of grain. Some adults of both species survived concentrations of carbon disulfide that reached 7.7, 9.9, 10.6, and 9.4 mg/L on days 1, 2, 3, and 4 after the initiation of fumigation. Successful control of both species was obtained with slightly higher gas concentrations or with longer periods of exposure to the gas.

Wheat treated with 2, 4, and 8 ppm of malathion, pirimiphos-methyl, cypermethrin, or permethrin and stored for 1 yr under Western Canadian storage conditions was bioassayed with the red flour beetle, the rusty grain beetle, and the grain mite *Acarus siro* Linnaeus at monthly intervals. Malathion was relatively ineffective; pirimiphos-methyl was the best insecticide, controlling both species of beetle for 9 mo (4 ppm) and 11 mo (8 ppm) as well as the grain mite; cypermethrin produced 90% knockdown of the red flour beetle (8 ppm) after 1 yr.

Malathion dust was applied to stored wheat at 1, 2, and 8 ppm. Eggs of the moths *P. interpunctella* and *E. cautella* were exposed to the wheat at 27°C and 15–18% MC. Levels of 1 ppm malathion controlled *P. interpunctella* larvae, 2 ppm controlled *E. cautella* larvae.

Columns of barley were placed on galvanized steel surfaces treated with malathion having an active ingredient (a.i.) of 0.5 g/m^2 and stored at 22°C (8–9% MC) or ambient conditions (–18° to 33°C, 12–16% MC) for 8 mo. Malathion levels of 53.09 ppm at 22°C, and 24.38 ppm at ambient conditions were present in barley at the 0–1 cm level at 8 mo; concentrates above 1 ppm were found at the 0–1, 1–2, and 2–3 cm levels at 22°C, and the 0–1 and 1–2 cm levels at ambient conditions at 8 mo.

Degradation of low levels of malathion on canola was studied at 10°, 20°, and 30°C and various MC (all "dry grade" moisture levels). Natural degradation from 0.72 ppm to 0.07 ppm occurred at 7.7% MC, 20°C in 8 mo, whereas lower MC had more gradual declines.

Malathion with an a.i. of 2% applied to sawdust controlled the red flour beetle on concrete for 1–3 mo at 25°C, and for more than 4 mo on wood and steel surfaces. The size of sawdust particles did not affect the rate of insecticide degradation: 92–95% on concrete, 37–53% on wood in 2 mo at 25°C.

Monitoring for malathion resistance identified resistant strains of the red flour beetle from ships at the East and West coasts, flour mills in Montreal, and farms in London, Ont., and southern Manitoba. Resistant strains of the confused flour beetle were found in southern Alberta, Winnipeg, Man., and Thunder Bay, Ont. No resistant strains of the rusty grain beetle have been found.

The potential of synergists to enhance the toxicity of the synthetic pyrethroid, permethrin, against the red flour beetle, was investigated. Of all the synergists tested, chlordimeform was the most effective and increased the toxicity of permethrin by a factor of 10, or more, at the LD_{50} level. Chlordimeform–permethrin mixtures also showed reduced heterogeneity of response, a desirable characteristic for reduced selection for insecticide resistance.

CROP PROTECTION

Research on insect pests of oilseed, cereal, and vegetable crops emphasizes aspects of their biology and control leading toward better prediction of infestations, crop protection, and the reduction of pest populations. The program includes the development of pest monitoring techniques, development and field testing of chemical and biological insecticides, and investigation of methods of reducing pest populations by biological and other nonchemical control methods. These programs are supported by research on sampling techniques, survival, development, phenology, host selection, induction and termination of diapause, overwintering strategies, reproductive biology, and biochemical bases of neurotransmission.

Monitoring and prediction

Few male moths of the bertha armyworm, *Mamestra configurata* Walker, were captured in sex attractant traps in Manitoba in 1982, and the absence of damaging larval populations was correctly predicted. Data on the prediction system that have been collected from endemic population levels in 1978, through an outbreak, to endemic population levels in 1983, are now complete. The use of sex attractant traps to monitor adult populations and to predict larval density is affected by crop development in canola: fields in the early bloom stage attract the most moths, but the total catch/field depends on the synchronization of this stage with the peak of moth flight. Larval survival is reduced in early maturing fields.

The total number of male redbacked cutworm moths, *Euxoa ochrogaster* (Guenée), captured in sex attractant traps was not significantly different among fields of wheat, barley, and canola under conventional, or zero, tillage. However, in conventionally tilled flax, the total captures were much greater, and in zero-tilled flax, they were less than in the other crops. Captures of the darksided cutworm, *E. messoria* (Harris), were low in all fields, with the largest number being captured in a zero-tillage canola field.

In 1983, approximately 3200 ha were sprayed for the control of grasshoppers in Manitoba, compared with 2425 ha in 1982. The forecast of grasshopper infestations in Manitoba in 1984, based on the adult survey, shows that the area infested has increased two and one-half times and the density of expected populations has also increased. Of the 6115 km^2 (2361 mi^2) rated as infested by grasshoppers in 1984, 4092 km^2 (1580 mi^2) were rated as light, 1932 km^2 (746 mi^2) moderate, and 91 km^2 (35 mi^2) severe. The largest and most heavily infested area is in southwestern Manitoba. The infested area extends from Oak Lake, south and west to the international and Saskatchewan boundaries. In the Red River valley, infestations are mainly along roadsides and the twostriped grasshopper, *Melanoplus bivittatus* (Say), is the dominant species. In the remainder of the province, pastures, hayland, and roadsides are infested. The clearwinged grasshopper, *Camnula pellucida* (Scudder), is the dominant species, followed by the migratory grasshopper, *Melanoplus sanguinipes* (Fabricius), and the twostriped grasshopper. The Packard grasshopper, *M. packardii* Scudder, is more abundant than in previous years.

Damage assessment

Final instar larvae (L6) of the bertha armyworm selected as food, in order of preference, leaves, bracts, immature, and mature pods of canola in laboratory tests. Fed exclusively, mature or immature pods were inferior to leaves for growth and development of L5 larvae to pupae. Pod feeding in the field on canola that has retained much leaf area must be derived from intrinsic climbing behavior of the larvae rather than the gustatory or nutritional properties of pods.

A 3-yr study on the abundance of pea aphids in field peas in Manitoba was completed. In each year, aphid densities peaked in late July or early August while pods were elongating or filling. The peak densities were between 10 and 100 per sweep and probably caused loss of yield in most fields. The most common cultivar of field peas, Century, had consistently lower densities of aphids than two other cultivars.

Insecticides

In field experiments for the control of the crucifer flea beetle, *Phyllotreta cruciferae*, on canola, insecticides were tested alone or in combination with fungicides or other insecticides, and at different rates of application as in-furrow granules, seed dressings, or post-emergence sprays.

In the first bioassay, 9 days after seeding, flea beetle mortality was high with most treatments. Exceptions were Furadan 9.4G and 10G, and the 10G formulation of Lance. These treatments, because of their slower activity at crop emergence, were the only granular treatments where the use of Vitavax RS Fl seed treatment in combination with them increased mortality. The remainder of the granulars generally performed as well when used with untreated seed as they did in combination with seed treated with a lindane–fungicide treatment. In the second bioassay, 15 days after seeding, Furadan Fl, Amaze, and Vitavax RS Fl were the only seed dressings that were still effective, whereas most of the granular treatments continued to be effective. In the third bioassay, 22 days after seeding, none of the seed dressings were effective, whereas mortality with many of the granular treatments ranged from 40% to 75% and with others, notably Furadan 9.4G, Lance 5G and 10G, and CGA 73102 5G, mortality was in the range of 79% to 100%. Some of the granulars continued to provide control in the range of 40–60%, 28 days after seeding. The persistence of Counter was reduced when sown with seed treated with Vitavax RS Fl seed dressing and compares with results obtained in 1981 and 1982 when seed treated with Gammasan$^+$ was used. The effectiveness of the insecticides in the bioassay was generally related to the numbers of new generation flea beetles collected, and seedling damage.

Plant stands in granular treatments sown with untreated seed, seed treated with a fungicide, or with a dual purpose seed dressing were not different from one another but lower than the stands in the seed dressing treatments. Poor stands in 1982 in granular treatments sown with untreated seed were not a problem in 1983. As noted previously, there appears to be a positive relationship between plant height and yield, where no such trend was evident with the length of the main raceme or number of pods. The use of a seed treatment in combination with a granular treatment did not increase yield significantly over that of a granular treatment alone. Yields with granular treatments in almost all instances were greater than those in seed dressing treatments, but a direct comparison cannot be made because of the difference in dates of seeding.

In one test where the overwintering generation of flea beetles was used in the bioassay, most of the spray treatments provided good initial knockdown, and their effectiveness was reflected in the bioassay. In general, the synthetic pyrethroids were slightly less effective than the other classes of insecticides.

In a second test where the summer generation of flea beetles was used in the bioassay, many of the treatments were slower in achieving mortality and were not as effective as they were against the overwintering generation. The sprays were applied at an air temperature of 35°C and this probably affected the performance of some of the insecticides, particularly the synthetic pyrethroids. Further testing is required to determine if there are differences in the efficacy of the insecticides in the control of overwintering and summer generations.

Biological control

A total of 1920 flea beetles, *Phyllotreta striolata* Fabricius, were exposed to the European parasite, *Townesilitus* (= *Microctonus bicolor*), in the laboratory and were released at Dauphin, Man. A total of 6104 flea beetle adults were collected at Glenlea in April 1983 and reared. There was no evidence of establishment of *T. bicolor* released there in 1978–1982. Numerous parasite adults were collected from a canola plot at the Glenlea release site during June–August 1983, but no *T. bicolor* were found.

Females of *T. bicolor* oviposit readily in *P. striolata*, occasionally in *P. cruciferae*, and not at all in *Psylliodes punctulata* Melsheimer. Immature parasites developed in *P. striolata* and *P. cruciferae*. Development of immature parasites was prolonged in superparasitized adults of *P. cruciferae*.

The commercial *Bacillus thuringiensis* (Bt) products, Thuricide 48LV(R) and Dipel 6L (R), were bioassayed against bertha armyworm larvae (L3 to L6) using a foliage-dipping technique and two temperatures, 22°C and 25°C. The data indicate that this armyworm is relatively resistant to commercial Bt in terms of mortality responses, but the bacterium had profound effects on larval and pupal weights, feeding activity, pupation, and adult emergence rates. To date, eight other strains of Bt also have been tested against the bertha armyworm. Of these, three are significantly more toxic than the commercial products.

A number of agriculturally important insect species from several locations across Canada have been tested in the laboratory for their susceptibility to two species of insect parasitic nematodes, *Neoplectana carpocapsae* and *Heterorhabditis bacteriophora*. The following species of insects were highly susceptible (i.e., 75–100% mortality): Oriental fruit moth, cabbage looper, bertha armyworm, army cutworm, *Euxoa pestula*, redbacked cutworm, dingy cutworm, armyworm, pale western cutworm, black army cutworm, sunflower moth larvae, Mediterranean flour moth larvae, European corn borer, woolly bear caterpillar, rutabaga root maggot, onion maggot, Colorado potato beetle larvae, red flour beetle, yellow mealworm, diamondback moth larvae, zebra caterpillar, imported cabbageworm, and pansy worm. The following species were weakly susceptible (less than 50% mortality): sugarbeet root maggot (summer larvae), *T. madens*, and *T. audax*. The following were not susceptible: apple maggot pupae, blueberry maggot pupae, sugarbeet root maggot (overwintering), prairie grain wireworm, and flea beetle adults.

Cage tests of the application of *Neoplectana carpocapsae* against the flea beetle, *P. cruciferae*, on rape were carried out at Morden. It appears that the new generation flea beetle populations were not affected by the nematodes applied to the soil. The application technique, persistence, and recovery of the nematodes from the soil were well established.

A colony of the parasite, *Aphidius smithi* Sharma Subba Rao, imported in June from California, was cultured in the laboratory, and more than 8000 adults were released at Glenlea on peas and alfalfa infested by the pea aphid, *Acyrthosiphon pisum* (Harris). The pea aphid population will be sampled in 1984 for establishment of the parasite.

Cultural control

Variations in autumn and winter survival of the bertha armyworm are strongly related to parasitism and cold stress in untilled soils and to cold stress in tilled soils. Tillage increased pupal mortality (*a*) in the autumn by injuring the pupae and exposing them to predation, (*b*) in the winter by reducing snow cover and soil temperatures in the absence of stubble, and (*c*) in the spring by lowering adult emergence.

Natural control

In collaboration with C. C. Loan, Ottawa Research Station, a key was prepared for six species of euphorines (*Townesilitus psylliodis* (Loan), *T. bicolor* (Wesm.), *Microctonus vittatae* Mues., *M. pusillae* Mues., *M. punctulatae* sp.m., and *M. zimmermanni* sp.n.) that parasitize crucier-infesting flea beetles. Descriptions were prepared for *M. punctulatae* and *M. zimmermanni*, and details of biology and life history for *M. vittatae*, *M. punctulatae*, and *T. psylliodis*. *M. vittatae* oviposited readily in the flea beetle *P. striolata*, less often in *P. cruciferae* and *Phyllotreta pusilla*, and rarely in *P. punctulata* Melsh.; the progeny matured in *P. striolata*, *P. cruciferae*, and *P. pusilla*. *M. punctulatae* oviposited readily in *P. punctulata* and *P. pusilla*, occasionally in *P. striolata*, but never in *P. cruciferae*; the progeny matured only in *P. punctulata* and *P. pusilla*. *T. psylliodis* oviposited readily in *P. punctulata*, rarely in *P. pusilla* and *P. striolata*, but never in *P. cruciferae*; the progeny matured only in *P. punctulata*.

Up until the end of 1983, no native parasites and predators of the red turnip beetle, *Entomoscelis americana* Brown, have been found in Manitoba.

The eggs, all larval instars, pupae, and adults of the armyworm, *Pseudaletia unipuncta* (Haworth), and the variegated cutworm, *Peridroma saucia* (Hübner), were tested for cold hardiness after rearing at both 15° and 20°C. For *P. unipuncta* the survival of eggs varied greatly among replicates, suggesting genetic variation among females. Larvae and pupae reared at 15°C were more cold tolerant than those reared at 20°C and third instar larvae and pupae were more tolerant than other stages. No adults survived 2 wk at 0°C.

The larvae of *P. saucia* would not rear satisfactorily at 15°C, but eggs from adults at 15°C were more cold tolerant than those from adults at 20°C. There were no differences in survival among any of the immature stages. Some adults survived 6 wk at 0°C. No stage of either species survived over 8 wk at 0°C or over 4 wk at −2°C, indicating that overwintering on the Canadian prairies is unlikely.

Biology

Starvation-related mortality was not high until newly hatched larvae of *E. americana* were starved for more than 2–4 days at 15°C and 1–2 days at 20° and 25°C, indicating that the first instar larvae have a relatively limited capability to withstand starvation. An evaluation of egg hatching and starvation data for the red turnip beetle, of germination data for canola, *Brassica campestris* L. and *B. napus* L., and of atmospheric air temperature and soil surface data for the areas where canola is grown, suggested that first instar larvae normally would not suffer high mortality due to starvation in growers' fields where volunteer seedlings of canola are the major larval food.

During embryological development in the fall, the embryos of *E. americana* have to reach a critical minimum stage of development to overwinter successfully and hatch. This stage occurs in the germ band formation stage. An evaluation of embryological and hatching data and of the atmospheric air temperature data suggests that embryo death due to eggs not reaching the critical minimum stage of development before winter normally should not be an important factor in the population dynamics of *E. americana* in the canola-growing areas of Western Canada.

Diapause in *P. cruciferae* requires no specific environmental stimulus for maintenance or termination, though it is affected by temperature and photoperiod. Diapause functions to prevent oogenesis during warm summer and autumn periods. Diapause ends after winter solstice but before the end of winter without the active intervention of a specific stimulus. Subsequent to diapause termination, insects remain quiescent until environmental conditions become favorable for oogenesis. Temperature seems to be the primary factor serving to synchronize the post-diapause activity to the seasonal occurrence of favorable conditions.

A 4-yr study on the seasonal pattern of flea beetle flight was completed. *P. cruciferae* was found to fly at higher elevations than *P. striolata* and both fly at higher elevations in the spring and early summer than in the fall. Beetles commonly fly at heights up to at least 7 m, suggesting that dispersal distances are probably quite long, especially in the spring. The seasonal pattern of flight and variability in numbers flying caused by weather are such that monitoring of flea beetles in early spring could not be a practical component of a pest control system.

The eggs of the corn stalk borer, *Helotropha reinformis* (Grt.), hatch in early May and the young larvae feed on grass. In early June, the larvae move into corn plantings and tunnel into the corn stalk, usually burrowing upward into the growing tip of the plant. They may attack and kill as many as seven plants before completing their larval development in mid-July. They pupate in the soil and adults emerge throughout August, at which time mating and oviposition occur. Eggs are deposited both in the corn and on grasses surrounding the field where they overwinter. Fall cultivation destroys most eggs in the corn and a general cleanup of headlands around the infested field should reduce the potential for infestation in the following year.

PUBLICATIONS

Research

Abramson, D.; Sinha, R. N.; Mills, J. T. 1983. Mycotoxin and odor formation in barley stored at 16 and 20% moisture in Manitoba. Cereal Chem. 60:350-355.

Ayre, G. L.; Turnock, W. J.; Struble, D. L. 1983. Spatial and temporal variability in sex attractant trap catches of *Leucania commoides* and *Peridroma saucia* (Lepidoptera: Noctuidae) in relation to their biology in Manitoba. Can. Entomol. 115:1573-1582.

Barker, P. S. 1983. Bionomics of *Lepidoglyphus destructor* (Schrank) (Acarina: Glycyphagidae) a pest of stored cereals. Can. J. Zool. 61:355-358.

Barker, P. S. 1983. Comparison of two pelletized formulations of aluminum phosphide for the control of adults and eggs of the rusty grain beetle (Coleoptera: Cucujidae) J. Econ. Entomol. 76:599-600.

Bodnaryk, R. P. 1982. The effect of single and combined doses of chlordimeform and permethrin on cAMP and gGMP levels in the moth, *Mamestra configurata* Wlk. Pestic. Biochem. Physiol. 18:334-340.

Bodnaryk, R. P. 1983. Regulation by Ca^{+} and calmodulin of brain adenylate cyclase from the moth, *Mamestra configurata* Wlk. Insect Biochem. 13:111-114.

Bucher, G. E.; Turnock, W. J. 1983. Dosage responses of the larval instars of the bertha armyworm, *Mamestra configurata* (Lepidoptera: Noctuidae) to a native nuclear polyhedrosis. Can. Entomol. 115:341-349.

Chong, J.; Ali-Khan, S. T.; Chubey, B. B.; Gubbels, G. H. 1983. Energy dispersive x-ray analysis of field peas with different cooking quality. Can. J. Plant Sci. 63:1071-1074.

Gerber, G. H.; Lamb, R. J. 1982. Phenology of egg hatching for the red turnip beetle, *Entomoscelis americana* (Coleoptera: Chrysomelidae). Environ. Entomol. 11:1258-1263.

Harder, D. E. 1982. Virulence and distribution of *Puccinia coronata* in Canada in 1981. Can. J. Plant Pathol. 4:299-302.

Harder, D. E.; Chong, J. 1982. Virulence and distribution of *Puccinia coronata* in Canada in 1982. Can. J. Plant Pathol. 5:185-188.

Hedgekar, B. M. 1983. Effect of latitude on the critical photoperiod for diapause induction in the bertha armyworm, *Mamestra configurata* (Lepidoptera: Noctuidae). Can. Entomol. 115:1039-1042.

Kim, W. K.; Rohringer, R.; Chong, J. 1982. Sugar and amino acid composition of macromolecular constituents released from walls of uredosporelings of *Puccinia graminis tritici*. Can. J. Plant Pathol. 4:317-327.

Kim, W. K.; Howes, N. K.; Rohringer, R. 1982. Detergent-soluble polypeptides in germinated uredospores and differentiated uredosporelings of wheat stem rust. Can. J. Plant Pathol. 4:328-333.

Lamb, R. J. 1983. Phenology of flea beetle (Coleoptera: Chrysomelidae) flight in relation to their invasion of canola fields in Manitoba. Can. Entomol. 115:1493-1502.

Loschiavo, S. R. 1983. Distribution of the rusty grain beetle (Coleoptera: Cucujidae) in columns of wheat stored dry or with localized high moisture content. J. Econ. Entomol. 76:881-884.

Loschiavo, S. R.; Sabourin, D. 1982. The merchant grain beetle, *Oryzaephilus mercator* (Silvanidae: Coleoptera) as a household pest in Canada. Can. Entomol. 114:1163-1169.

MacKay, R. A.; Reelder, D. J.; Lamb, R. J. 1983. Sexual morph production by apterous and alate viviparous *Acyrthosiphon pisum* (Harris) (Homoptera: Aphididae). Can. J. Zool. 61:952-957.

Madrid, F. J.; Sinha, R. N. 1983. Movement and oviposition of *Ephestia cautella* (Walker) and *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae) of different ages in response to seasonal light changes. Can. J. Zool. 61:1726-1732.

Martens, J. W. 1983. Incidence and virulence of *Puccinia graminis* on wheat, barley and rye in Canada in 1982. Can. J. Plant Pathol. 5:197-199.

Martens, J. W.; Harder, D. E. 1983. Incidence and virulence of *Puccinia graminis* f. sp. *avenae* in Canada in 1982. Can. J. Plant Pathol. 5:189-193.

Mills, J. T. 1983. Use of photographic film as a substrate for localization of protease activity by fungi on rape seeds. Can. J. Plant Pathol. 5:21-24.

Morris, O. N. 1983. Comparative efficacy of Thuricide 16B and Dipel against the spruce budworm, *Choristoneura fumiferana*, in balsam fir stands. Can. Entomol. 115:1001-1006.

Morris, O. N. 1983. Protection of *Bacillus thuringiensis* from inactivation by sunlight. Can. Entomol. 115:1215-1227.

Nielsen, J. 1983. Spring wheats immune or highly resistant to *Ustilago tritici*. Plant Dis. 67:860-863.

Samborski, D. J. 1983. Occurrence and virulence of *Puccinia recondita* in Canada in 1982. Can. J. Plant Pathol. 5:194-196.

Sebesta, J.; Harder, D. E. 1983. Occurrence and distribution of virulence in *Puccinia coronata avenae* in Europe, 1977–1980. Plant Dis. 67:56-59.

Sinha, R. N. 1983. Effects of stored-products beetle infestation on fat acidity, seed germination and microflora of wheat. J. Econ. Entomol. 76:813-817.

Smith, L. B. 1983. The relationship between wet grain, *Cryptolestes ferrugineus* (Coleoptera: Cucujidae) populations, and heating in wheat stored in granaries. Can. Entomol. 115:1383-1394.

Thomas, P. L. 1983. Inheritance of virulence of *Ustilago nuda* on the barley cultivars Warrior, Compana, Valkie, Keystone, and Bonanza. Can. J. Genet. Cytol. 25:53-56.

Turnock, W. J.; Lamb, R. J.; Bodnaryk, R. P. 1983. Effects of cold stress during pupal diapause on the survival and development of *Mamestra configurata* (Lepidoptera: Noctuidae). Oecologia (Berl.) 56:185-192.

Van Caeseele, L.; Mills, J. T.; Sumner, M.; Gillespie, R. 1981. Cytology of mucilage production in the seed coat of Candle canola (*Brassica campestris*). Can. J. Bot. 59(3):292-300.

Walden, T. L., Jr.; Howes, N. K.; Farkas, W. R. 1982. Purification of quanine, queuine-tRNA transglycosylase from wheat germ. J. Biol. Chem. 257:13218-13222.

Watters, F. L.; White, N. D. G.; Cote, D. 1983. Effect of temperature on toxicity and persistence of three pyrethroid insecticides applied to fir plywood for the control of the red flour beetle (Coleoptera: Tenebrionidae). J. Econ. Entomol. 76:11-16.

White, N. D. G. 1982. Effectiveness of malathion and pirimiphos-methyl applied to plywood or concrete to control the larger grain borer (Coleoptera: Bostrichidae). Proc. Entomol. Soc. Ont. 113:65-69.

White, N. D. G. 1983. Effect of continuous exposure of malathion-resistant red flour beetles (Coleoptera: Tenebrionidae) to malathion-treated wheat or wheat exposed to treated surfaces. J. Econ. Entomol. 76:657-661.

White, N. D. G.; Nowicki, T. W.; Watters, F. L. 1983. Comparison of fenitrothion and malathion for treatment of plywood and galvanized steel surfaces for control of the red flour beetle (Coleoptera: Tenebrionidae) and the rusty grain beetle (Coleoptera: Cucujidae). J. Econ. Entomol. 76:856-866.

Wong, L. S. L.; McKenzie, R. I. H.; Harder, D. E.; Martens, J. W. 1983. The inheritance of resistance to *Puccinia coronata* and of floret characters in *Avena sterilis*. Can. J. Genet. Cytol. 25:329-335.

Wylie, H. G. 1983. Oviposition and survival of the European parasite *Microctonus bicolor* (Hymenoptera: Braconidae) on crucifer-infesting flea beetles (Coleoptera: Chrysomelidae) in Manitoba. Can. Entomol. 115:55-58.

Wylie, H. G. 1983. Delayed development of *Microctonus vittatae* (Hymenoptera: Braconidae) in superparasitized adults of *Phyllotreta cruciferae* (Coleoptera: Chrysomelidae). Can. Entomol. 115:441-442.

Miscellaneous

Ayre, G. L. 1983. Strawberry cutworm. Insect identification sheet No. 91. Agric. Can., Ottawa.

Bodnaryk, R. P. 1983. Cyclic nucleotides. *In* Endocrinology of insects. New York, NY: Alan R. Liss, Inc. pp. 567-614.

Gerber, G. H. 1982. A pest management system for the red turnip beetle on rapeseed and canola. Can. Agric. 27(3):8-11.

Kim, W. K.; Rohringer, R.; Howes, N. K.; Chong, J. 1983. Approaches for the detection of the products of genes for resistance and avirulence in the wheat and stem rust system. Pages 227-236 *in* Akazawa, T.; Ashai, T.; Imaseki, J., eds. The new frontiers in plant biochemistry. Japan Scientific Societies Press, Tokyo, Japan.

Lamb, R. J.; MacKay, P. A. 1983. Micro-evolution of the migratory tendency, photoperiodic response and developmental threshold of the pea aphid, *Acyrthosiphon pisum*. Pages 209-217 *in* Brown, V. K.; Hodek, I., eds. Diapause and life cycle strategies in insects. Dr. W. Junk, publisher.

Martens, J. W. 1982. Stem rust of oats. Canadex 113:630.

Nielsen, J.; Thomas, P.; Duczeck, L.; Rossnagel, B. 1983. Recognize and prevent smuts in barley. Agdex 632.

Turnock, W. J. 1982. Opportunities for biocontrol in the development of pest management systems for insects attacking canola in western Canada. Biocontrol News Info. 3:279-286.

Turnock, W. J.; Lamb, R. J. 1982. Protecting canola from flea beetle damage. Can. Agric. 28(4):4-9.

White, N. D. G.; Sinha, R. N.; Mills, J. T. 1983. Malathion applied to wheat as it enters a granary. Canadex 705.67.

Research Station
Melfort, Saskatchewan

PROFESSIONAL STAFF

S. E. Beacom, B.Sc., M.Sc., Ph.D.	Director
G. M. Bell	Administrative Officer
D. J. Ewanus, B.Sc.	Farm Manager

Forage Production and Utilization

J. A. Robertson, B.Sc., M.Sc., Ph.D.	Program Leader; Beef cow–calf nutrition, pasture management
S. E. Beacom, B.Sc., M.Sc., Ph.D.	Utilization of harvested forages
S. Bittman, B.Sc., M.Sc.	Forage crop production
E. Z. Jan, B.Sc., M.Sc., Ph.D.	Forage harvesting systems
D. H. McCartney, B.Sc., M.Sc.	Beef cow–calf management systems
Z. Mir, B.Sc., M.Sc., Ph.D.	Ruminant nutrition, forage utilization
J. Waddington, B.Sc., M.Sc., Ph.D.	Forage ecology and weed control

Cereal, Oilseed, and Special Crop Production

K. E. Bowren, B.S.A.	Program Leader; Crop production
W. F. Nuttall, B.Sc., M.Sc., Ph.D.	Soil fertility, crop nutrition
A. T. Wright, B.S.A., M.Sc.	Crop evaluation and agronomy

INTRODUCTION

Researchers at the Melfort Station are developing more efficient forage production, harvesting, storage, and utilization systems to provide beef cattle producers with a wider range of feeding alternatives and to encourage greater use of forage crops in rotations in the interests of better land management. They are also involved in the evaluation of a wide range of crops and in the development of improved agronomic practices designed to optimize production over the long term. A large-scale project in cooperation with the Saskatchewan Department of Agriculture and the Saskatchewan Horned Cattle Trust Fund Committee is under way to develop more efficient beef cow–calf management systems in the aspen parkbelt. We also acknowledge the excellent support from Alberta's Farming for the Future program, which made possible studies on energy requirements of forage system components and the evaluation of a roller-herbicide applicator for brush control on pasture. It also greatly facilitated studies to evaluate additives and implants for finishing cattle.

In January 1983, Dr. Zahir Mir, who received his Ph.D. degree from the University of Guelph, specializing in ruminant nutrition, joined our staff to undertake forage utilization research.

Brief summaries of some of our work are presented here. For more information, readers may obtain a copy of our *Research Highlights 1983* by writing to the Research Station, Research Branch, Agriculture Canada, Box 1240, Melfort, Sask. S0E 1A0. (Telephone: (306)752-2776; Telex: 074-29122)

S. E. Beacom
Director

FORAGE PRODUCTION AND UTILIZATION

Roller-applied herbicides for brush control

In a 3-yr study, in cooperation with Alberta's Farming for the Future program, the application of herbicide for brush control on pasture by means of a roller applicator was evaluated. Optimum roller speed of 60 rpm minimized dripping and splashing of herbicide from the roller. From 130 to 300 L/ha of herbicide solution was applied, depending on the size and density of the brush. With 2-m-high brush approximately 5% of the leaf surface was wetted. Of the herbicide concentrations tested (0.17–13.5% v/v), 1.5% was best in a once-over application.

Willows (*Salix* spp.) up to 1.5 m were killed with one application of 2,4-D [(2,4-dichlorophenoxy)acetic acid], whereas some stems of 2-m-high plants survived. Glyphosate [*N*-(phosphonomethyl)glycine] or a 3:1 mixture of 2,4-D:picloram (4,amino-3,5,6-trichloropicolinic acid) controlled poplar species (*Populus* spp.). Some regrowth from balsam poplar (*Populus balsamifera*) roots occurred. Control of rose (*Rosa* spp.) and western snowberry (*Symphoricarpos occidentalis*) was much less consistent, because they are shorter (<1 m), and the flexibility of the rose stems precluded application of a lethal dose. With the bottom of the roller set at 30 cm from the ground for rose and snowberry control using glyphosate, forage grasses could receive lethal amounts of herbicide.

With the roller set at or over 0.5 m from the ground, damage to forage was negligible but short woody growth was not controlled.

Effect of herbicides on seed production of bromegrass, crested wheatgrass, and timothy

Over a 3-yr period, spring application of wild oat herbicides benzoylprop ethyl [ethyl 2-(3,4-dichlorophenyl)benzamide propionate], diclofop methyl [methyl 2-(4-(2,4-dichlorophenoxy)phenoxy propionate], difenzoquat (1,2-dimethyl-3,5-diphenylpyrazolium methyl sulfate), and flamprop methyl [methyl 2- (*n*- (3-chloro-4-fluorophenyl) benzamido)-propionate] to established bromegrass reduced seed yield by 37 kg/ha (control yield 158 kg/ha). In the 1st yr of seed production, application of diclofop methyl weakened the stem, resulting in lodging just prior to harvest.

In 1979, application of benzoylprop ethyl at the rate of 2 kg/ha reduced the yield of crested wheatgrass seed by 16% (control 652 kg/ha). In 1980 and 1981, seed yields were only 100 kg/ha, because of spring drought. Flamprop methyl and benzoylprop ethyl reduced yields by 30% and 19%, respectively. None of the herbicides produced visible effects during the growing season.

The application of difenzoquat, diclofop methyl, or flamprop methyl to timothy in each of 2 yr, caused stunting, reductions in heading, delays in maturity, and reductions in seed yields. In 1981, propanil [*n*-(3,4-dichlorophenyl)propionamide] also reduced seed yields.

Remote sensing of pastures

A remote sensing technique to determine biomass of pastures in the aspen parklands has been developed in cooperation with Intera Environmental Consultants Ltd., Calgary, Alta. In a 3-yr study using 23-cm and 35-mm color infrared (CIR) aerial photo transparencies it was found that biomass estimates could be made to a level of precision of 20 g/m^2 in June compared to 40 g/m^2 in July. Both large scales of 35-mm CIR photography (1:2500 and 1:5000) provided biomass estimations of equivalent accuracy and the best photographic interpretation was derived by assessing textures rather than colors and patterns. The cheaper 35-mm CIR transparencies provided color and texture information equal to that obtained from 23-cm CIR photography at equivalent scales. There were no significant differences among photo interpreters in their accuracy of estimating biomass, and the method gives consistent results between years and locations.

Aureomycin versus monensin beef finishing rations

In a replicated experiment, 452 steers and heifers were fed ground hay (94%)- or rolled barley (88%)-based rations supplemented with aureomycin (average 110 mg/day per head) or monensin (average dry matter content of 30 mg/t). The effects of implanting steers with either Synovex S or Ralgro, and heifers with Synovex H were also determined.

For unimplanted heifers fed forage, replacing aureomycin with monensin (Rumensin) improved rate of gain (RG) (6%) and feed efficiency (FE) (6%) but reduced dressing percentage (DP) by 1.5 units, reducing returns to labor (RL) by $9 per head. With implanted heifers, monensin reduced RG (5%), had no effect on FE or DP, and reduced RL by $11. Synovex increased RL from heifers fed aureomycin by $14 and from those fed monensin by $11.

For unimplanted grain-fed heifers, replacing aureomycin with monensin reduced RG (10%), reduced FE (8%), had no effect on DP, and reduced RL by $20. With implanted heifers, monensin reduced RG (10%), improved FE (4%), reduced DP by 0.9 unit, and reduced RL by $7. Synovex increased RL of aureomycin-fed heifers by $4, and monensin-fed heifers by $18.

For unimplanted forage-fed steers, replacing aureomycin with monensin reduced RG (3.4%), FE (1.3%), and RL by $4. For Synovex-implanted steers, monensin improved RG (5%) and FE (5%) but reduced DP by 0.6 unit and RL by $7. For Ralgro-implanted steers, monensin reduced RG (1.5%) and improved FE (1.7%), increasing RL by $3. On average, Synovex increased RL by $25, Ralgro by $6.

For unimplanted grain-fed steers, replacing aureomycin with monensin reduced RG (12%), improved FE (7%), reduced DP by 0.25 unit, and reduced RL by $6. For Synovex-implanted steers, monensin reduced RG by 9%, improved FE by 5%, reduced DP by 0.9 unit, and reduced RL by $9. For Ralgro-implanted steers, monensin reduced RG (4%), FE (1%), DP by 1.6 units, and RL by $26. On average, both Synovex and Ralgro increased RL by $25.

Under our conditions, and at the levels used, aureomycin was more effective than monensin, particularly with barley-based rations.

Energy supplementation of forage diets for lambs

A ground hay-based ration (18.4% crude protein) was supplemented with 3, 4, and 5% of either acidulated fatty acids (AFA) or tallow and self-fed to 84 growing lambs averaging 23 kg at the start of the test (randomized complete block design with 12 replicates per treatment). Addition of AFA at 5% and tallow at all three levels resulted in significant increases ($P < 0.05$) in liveweight gain ranging from 9% to 20% over the control lambs (283 g/day). Feed efficiency was increased significantly ($P < 0.05$) for all energy-supplemented diets (range from 10% to 16% over control). Highest net return per lamb over control was obtained for 3% tallow and 5% AFA at $3.33 and $3.05, respectively.

Cow–calf management

Evaluation of a vaccine for neonatal diarrhea in calves. In collaboration with the Veterinary Infectious Diseases Organization (VIDO), an experimental vaccine developed by VIDO to prevent viral scours was tested in 80 cows to determine which of several adjuvants stimulated the highest antibody titers to coronavirus and to rotavirus. Four different combinations of an oil-based adjuvant (Marcol 52) and emulsifiers, and a water-soluble adjuvant were tested. Cows were vaccinated twice, 7 wk apart, during the second half of gestation. Blood samples were taken before and after vaccination and tested for antibodies to both viruses. With rotavirus, vaccinated cows in all groups had a significant increase in rotavirus antibody titer following vaccination and there were no significant differences between adjuvants. For coronavirus, neutralizing antibody titers before and after vaccination were 593 and 10 590, and 406 and 4421 for the groups given water-based and oil-based adjuvants, respectively. In unvaccinated control cows there was no increase in antibody titer to either virus. The oil-based adjuvant may not be suitable for widespread usage in commercial herds due to development of swellings at the injection site in approximately 10% of the cows. These studies are helping to develop a vaccine that will control much of the virus-related scours which occur during the first month of life.

CEREAL, OILSEED, AND SPECIAL CROP PRODUCTION

Septoria in wheat

In recent years, there has been a serious buildup in the Septoria complex of diseases in wheat. Twelve lines were screened for field resistance, but there was little difference in either leaf or head discoloration among those varieties accounting for most of the wheat hectarage. Park had considerably greater foliar destruction and Pembina noticeably more glume discoloration than the other lines. HY407, HY307, and Glenlea had greater resistance to these diseases.

No fungicides are registered in Canada for control of Septoria diseases; however, aerial spraying of wheat at the milk stage with Bravo 500 and Benlate resulted in significant yield increases of 340 and 400 kg/ha, respectively. In other testing, the mixture of Benlate and Tilt resulted in significantly increased kernel filling.

HY320, the 3M wheat line, has yielded 138% of Neepawa in 8 yr of testing on the black and gray soils of northeastern Saskatchewan.

Net blotch in barley

There has been considerable yield loss in two-row barley due to net blotch infection during the past 2 yr in northeastern Saskatchewan. Norbert is the only licensed two-row variety with acceptable field resistance. Elrose is particularly susceptible, and production of this variety is strongly discouraged.

Effect of burning versus tillage of stubble on wheat yields

In a 24-yr experiment under continuous wheat cropping on a Melfort silty clay loam, fall tillage with four different machines was compared with spring burning of stubble and no fall tillage. Four levels of N fertilizer were applied annually across each tillage treatment. Tillage treatment had no significant effect on yield (mean 1912 kg/ha). Nitrogen at 45 kg/ha increased yield by 29% over all tillage treatments and increased the protein content of the grain from 14.1% to 15.3%. Moisture buildup from fall to spring was increased by 1.6 cm (5.3 versus 3.7) where the stubble was left standing to trap snow.

Fall tillage had no advantage over spring burning from the standpoint of yield or weed control, but burning permanently diminished bacterial population, biological activity, total carbon and nitrogen concentration, and water permeability of the soil.

Studies on triazine-tolerant canola

Cyanazine at 1.0–1.5 kg/ha postemergence and metribuzin at either 0.21 kg/ha postemergence or 0.3–0.5 kg/ha tank-mixed with trifluralin at 1.1 kg/ha preplant-incorporated, provided acceptable control of stinkweed and wild mustard in triazine-tolerant canola. These herbicides could also be used in combination with herbicides recommended for weed control in regular canola for the control of additional broad-leaved or grass-type weeds in triazine-tolerant canola.

The yield of the triazine-tolerant line tested was only 86% of that of Westar with a 1000 kernal weight of 3.405 g compared to 3.570 g for Westar.

PUBLICATIONS

Research

Curry, P. S.; Knowles, R. P.; Waddington, J. 1983. Seasonal occurrence and chemical control of the bromegrass seed midge, *Contarinia bromicola* (Diptera: Cecidomyiidae) in Saskatchewan. Can. Entomol. 115:75-79.

Waddington, J.; Bittman, S. 1983. Bromegrass and alfalfa establishment with a wheat companion crop in northeastern Saskatchewan. Can. J. Plant Sci. 63:659-668.

Robertson, J. A. 1983. Influence of harvesting and conservation practises on forage quality. Can. J. Plant Sci. 63:913-925.

Miscellaneous

Bowren, K. E. 1983. Wild oat control with minimum and zero tillage. Can. Plains Proc. No. 12, Wild Oat Symposium, Regina, Oct. 18-19. pp. 53-60.

McCartney, D. H.; Robertson, J. A. 1983. The economic effects of fertilizing, rebreaking and reseeding as a method of rejuvenating roughland pastures in the Aspen Parkland. Proceedings of the Canadian Society of Animal Science, Saskatoon.

McCartney, D. H.; Waddington, J.; Thompson, D.; Dams, B. 1983. Remote sensing for estimating the biomass levels in seeded rangelands of western Canada. Proceedings of the 1983 Congress of American Society of Range Management.

Thompson, M. D.; Dams, R. V.; McCartney, D. H. 1983. Remote sensing for productivity estimation in western Canadian seeded pastures. Proceeding Conference on the Application of Remote Sensing Techniques to Aid Range Management. National College of Agricultural Engineering, Silsoe, Bedford, England.

Thompson, M. D.; Dams, R. V.; McCartney, D. H. 1983. The use of remote sensing to estimate productivity in a parkland seeded pasture. Proceedings of 8th Canadian Symposium on Remote Sensing.

Research Station
Regina, Saskatchewan

PROFESSIONAL STAFF

J. Dueck, B.S.A., M.Sc., Ph.D.	Director
D. I. Gourlay	Administrative Officer
C. J. Bubar, B.S.A., M.Sc.	Information Officer
S. P. Yanosik[1]	Library Technician

Biological Control of Weeds

P. Harris, B.S.F., D.I.C., Ph.D.	Head of Section; Entomology
M. G. Maw, B.Sc., M.Sc.	Entomology
K. Mortensen, B.Sc., Ph.D.	Plant pathology
D. P. Peschken, B.S.A., M.Sc., Dr.Sci.Agr.	Entomology

Weed Ecology and Physiology

G. I. McIntyre, B.Sc., Ph.D.	Head of Section; Physiology, water relations, dormancy
G. G. Bowes, B.S.A., M.Sc. Ph.D.	Range weeds
A. I. Hsiao, B.Sc., M.Sc., Ph.D.	Physiology, dormancy
L. Hume, B.Sc., Ph.D.	Crop losses, ecology
J. H. Hunter, B.S.A., Ph.D.	Control—annual crops
A. G. Thomas, B.Sc., M.Sc., Ph.D.	Surveys, ecology

Environmental Chemistry of Herbicides

R. Grover, B.Sc., M.Sc., Ph.D.	Head of Section; Availability, mobility
A. J. Cessna,[2] B.A., Ph.D.	Residues, plants
A. E. Smith, B.Sc., Ph.D., D.Sc., F.C.I.C.	Residues, metabolism, soils

Seed Increase

G. R. Boughton, B.S.A., M.Sc.	Head of Section

Experimental Farm, Indian Head, Sask.

VACANT	Superintendent
VACANT	New Crops

Departures

N. W. HOLT, B.S.A., Ph.D. Transferred to Research Station, Swift Current, September 1983	Forage and new crops
E. D. MALLOUGH, B.S.A. Transferred to Prairie Region Headquarters, Saskatoon, January 1983	Seed increase
W. B. TOWILL, B.S.A. Retired December 1983	Superintendent

VISITING SCIENTIST

W. A. QUICK, B.A., B.Ed., M.A., Ph.D.	Weed physiology

Graduate student

K. P. BROWNE, B.Sc.	Weed physiology

---

[1] Seconded from Libraries Division, Finance and Administration Branch, June 83.
[2] On Transfer of work from April 1983.

INTRODUCTION

The Regina Research Station continued to make good progress in the study of the biology and control of weeds in cultivated crops and pastures. The station has projects on biological control, weed surveys, crop loss, plant physiology, and herbicide chemistry in the environment which are national in scope. Collectively, they are designed to improve the effectiveness of weed control, reduce dependence on pesticides, and improve the safety of pesticide use for farmers, the consuming public, and the environment.

In addition to the weed research program, the station has responsibility for increase of new crop varieties developed by Agriculture Canada and for a winter plant breeding nursery in California. Cereals, oilseeds, forages, and pulse crops are evaluated for adaptability to southeastern Saskatchewan. Agronomic experiments develop information for soil and crop management.

Enquiries for detailed information on research activities may be directed to the Research Station, Agriculture Canada, 5000 Wascana Parkway, P.O. Box 440, Regina, Sask. S4P 3A2.

J. Dueck
Director

BIOLOGICAL CONTROL

Canada thistle

The leaf-feeding beetle *Lema cyanella* (L.) was released at Indian Head, Sask., and Sussex, N.B., for biological control of Canada thistle. Breeding took place at both sites, but mortality of larvae was high and successful establishment will not be determined with certainty until spring 1984. The release of this insect is an important milestone in the debate between taxonomists concerned about populations of native thistles and agriculturalists attempting to control populations of weedy species. Experimental evidence obtained prior to the release indicated that, although *L. cyanella* would feed on non-target native thistles in starvation, given a choice the insect would feed on the most abundant host species present, which is invariably the damaging weed species. This study, in addition to providing data for release of *L. cyanella*, will provide background for future release of introduced biocontrol insects on thistle species.

Review of biological control projects

Eighteen manuscripts reviewing all biological control work on weeds in Canada for the period 1969–1980 were prepared for a Commonwealth Institute of Biological Control Technical Communication. The reviews provide important information for scientists working in biological control of weeds which will be useful in determining present and future directions of research. The species included in the reviews are as follows: leafy and cypress spurge, nodding thistle, bull thistle, Canada thistle, Russian thistle, sow-thistle, yellow and broad-leaved toadflax, St. John's wort, diffuse and spotted knapweed, Russian knapweed, tansy ragwort, bindweed, ragweed, mullein, bladder campion, absinth, prickly-pear cactus, and buckthorn.

Guidelines for evaluation of proposed biological control projects

A format for determining the ecological and monetary benefits of biological control was developed and tested on leafy spurge. This format, which has been accepted by both Agriculture Canada and the U.S. Department of Agriculture, examines potential target weeds in terms of taxonomy, pest status, possibilty of conflicts of interest, biological control strategies, proposed test plants, and candidate biological control agents. It is felt that this system of more fully examining the pros and cons of biocontrol will ensure that projects are only conducted on undesirable weeds that have no alternate satisfactory means of control. In the case of leafy spurge, it was found that there is a sufficiently large infestation of 454 000 ha of rangeland in Western Canada and North Dakota coupled with a corresponding lack of economic, safe chemical control measures to warrant increased efforts in biological control. As a result, five species of insects have been screened and are ready for field evaluation.

WEED ECOLOGY AND PHYSIOLOGY

Weed surveys

Weed surveys examining the density and distribution of weeds in cereal, oilseed, forage, and row crops in Prince Edward Island, Ontario, Saskatchewan, and British Columbia were completed in a total of 6500 fields in cooperation with the staff of provincial departments of agriculture and other research stations. The studies, which varied from 2 to 4 yr in duration, were published in six Weed Survey Series reports that were distributed to research, extension, and industry personnel. These reports contain the first quantitative assessments of the relative importance of approximately 250 weedy species.

Loss in rapeseed caused by perennial sow-thistle

Field studies were conducted to determine yield losses caused by perennial sow-thistle in rapeseed fields in Saskatchewan and Manitoba. The relationship between percentage of yield loss and density of perennial sow-thistle was expressed by the linear regression equation $y = -3.81 + 13.76 \sqrt{x}$. Weed survey data indicated that perennial sow-thistle occurred in 39% of the rapeseed fields but infested only 7% of the hectares surveyed. Using both the survey data and the yield loss equation, the average annual loss in rapeseed yield was estimated to be 9.4 million kg in Saskatchewan and 6.1 million kg in Manitoba, with a value of $2.6 million and $1.7 million, respectively. Perennial sow-thistle occurs with a similar frequency and density in other crops so that the total loss from this weed would be much greater.

Long-term effects of fertilizer application and three rotations on weed communities in wheat

The effect of fertilizer application and three rotations—continuous cropping, fallow–wheat, and fallow–wheat–wheat—on the species composition of the weed community was examined, using experiments that had been running for 21–22 years at Indian Head, Sask. Before seeding, it was found that green foxtail was most abundant in continuous cropping, whereas stinkweed and lamb's-quarters were more abundant in the fallow–wheat and fallow–wheat–wheat rotations. After seeding, the most serious weed problem was in the continuously cropped plots which contained the largest densities of green foxtail, thyme-leaved spurge, and vetch. In the absence of fertilizer, Canada thistle was also most abundant under continuous cropping. In general, fertilizer application tended to reduce community differences between continuous cropping and the short-term wheat–fallow rotations. The results indicate that weed problems can be minimized in southeastern Saskatchewan with the use of 2 or 3 yr wheat–fallow rotations and herbicide application.

Seed dormancy in wild oats

A characteristic feature of the seed of wild oats is that the primary seeds are larger and considerably less dormant than the secondary ones. Experiments conducted under controlled conditions showed that removal of the primary seeds shortly after anthesis markedly increased the dry weight of the secondary seeds and caused a significant reduction in their degree of dormancy. Removal of the secondary seeds has a much smaller effect on the growth and germination of the primary ones. These results suggest, as a working hypothesis, that dormancy in wild oats may be affected by competition for water and nutrients between the developing seeds, and that the primary seeds are the more effective competitors, probably by virtue of their prior inception.

Control of root bud growth in perennial weeds

A study of the mechanism of root bud inhibition in milkweed showed that the growth of the buds was increased within 24 h of the excision of the parent shoot. At low relative humidity (RH) (30–50%), decapitated, disbudded stems, bearing only a single pair of leaves, promoted the early growth of the root buds but strongly inhibited their subsequent elongation and emergence as shoots. The mature stem itself, when completely defoliated, also exerted a significant degree of inhibition of root shoot production. At higher RH (93–100%), which reduced transpiration by approximately 50%, this inhibiting effect of mature shoot tissue was either eliminated or greatly reduced. Similar results were obtained in previous experiments with leafy spurge and in current investigations with Canada thistle. These results provide support for the hypothesis that transpiration-induced reduction in water potential plays a major role in the mechanism of root bud inhibition.

Foxtail barley control

Experiments on the selective control of foxtail barley within established stands of Russian wild ryegrass were conducted at two sites in southern Saskatchewan. It was found that propyzamide applied at 0.5–1.0 kg/ha controlled foxtail barley, and crop tolerance was good at even the highest rate. Fall applications of propyzamide were found to be superior to spring applications both in terms of reduction in foxtail barley, growth and tolerance of the Russian wild ryegrass. In the presence of the competitive forage crop, an application of propyzamide was shown to be effective for the control of foxtail barley for a period of at least 3 yr.

ENVIRONMENTAL CHEMISTRY OF HERBICIDES

Bioavailability of atrazine

A study to determine the bioactivity of atrazine in nine representative Saskatchewan soils showed that the amount of herbicide required to reduce the growth of oat shoots by 50% (GR_{50}) varied from 0.09 μg/g for Asquith sandy loam to 1.73 μg/g for Melfort silty clay loam. As expected, soil organic matter content was significantly correlated to GR_{50}. In addition, when the amorphous oxides of Al and Fe were extracted with pyrophosphate, each also showed a high correlation with GR_{50}. The data indicate that both the soil organic matter content and pyrophosphate extractable amorphous oxides may be used as indicators of atrazine bioavailability in Saskatchewan, which would vary according to location and soil type.

Herbicide persistence in soils

Two degradation products of 2,4-D—2,4-dichlorophenol and 2,4-dichloroanisole—were extracted from Saskatchewan soils and identified. The existence of these products has long been postulated but this is the first report of their isolation from treated soils. However, given the volatile nature of both compounds, it is very doubtful whether buildup of either the phenol or anisole of 2,4-D would occur in soils under field conditions. It is only in systems where volatility losses can be reduced that these 2,4-D degradation products can be isolated and detected.

The soil persistence of the seven most commonly used herbicides in Saskatchewan—bromoxynil, dicamba, MCPA, propanil, triallate, trifluralin, and 2,4-D—was studied both singly and in the presence of other herbicides applied as tank mixes. Results of the laboratory studies, which were conducted on heavy clay, clay loam, and sandy loam soils at 85% of field capacity and 20°C, showed that soil degradation of all the herbicides was unaffected by combined application with other chemicals regardless of the soil type.

The degradation of ring-labeled [^{14}C]dicamba, [^{14}C]2,4-D, [2-^{14}C]triallate, and [^{14}C]trifluralin was studied under field conditions at rates of 1 kg/ha in small sandy loam plots. After 45 wk, soluble radioactivity recovered from the dicamba-, 2,4-D-, triallate-, and trifluralin-treated plots were <1, 2, 50, and 77% of that applied, whereas the nonextractable activity accounted for 2, 10, 15, and 10% of that initially applied. After 95 wk, <1, 1, 16, and 38% of the applied radioactivity was, on the average, extractable from the dicamba-, 2,4-D-, triallate-, and trifluralin-treated plots, whereas 3, 6, 30, and 22%, respectively, remained in a solvent nonextractable form.

CROP MANAGEMENT

Influence of plant density on growth of sunflowers

A study to investigate the influence of plant density on several agronomic traits of four sunflower cultivars was conducted under dryland conditions at Indian Head and Saskatoon, Sask. Increases in plant density from 40 000 to 85 000 plants per hectare were associated with small increases in percentage of oil content of 44.3–45.6%, whereas seed yield was unaffected. Days to flower, plant height, and test weight increased with increases in plant density, whereas days to maturity, head diameter, and average seed weight decreased. There was no interaction between cultivars and plant density. However, environment (five location-years) had a significant effect on all variables. The results suggest there is an opportunity to develop sunflower cultivars adapted to dryland prairie conditions.

Availability of residual fertilizer phosphorus

The magnitude and duration of response of bromegrass–alfalfa to a one-time application of P fertilizer in 1970 were studied at rates of P to 144 kg/ha. All treatments produced residual effects which were reflected by increased forage yields, forage P content, and forage uptake of P by bromegrass–alfalfa during the years 1972–1976. An annual application of N, P, and S at the rates of 18, 10, and 16 kg/ha, respectively, when combined with the 1970 application of P, had no further significant effect on forage yields, although forage P and uptake of P were both increased. Soil sodium-bicarbonate-extractable P was proportional to applied P, but the amount of available P decreased during the 10 yr test period. Although the portion of alfalfa in the dry matter generally increased over time, the alfalfa content was not related to the applied P.

SEED INCREASE AND DISTRIBUTION

In 1983, Agriculture Canada released to the SeCan Association 9277 kg of Kamouraska oats and 1329 kg of Signal bromegrass. In addition, 250 kg of FP707 flax and 500 kg of TR212 barley were released to SeCan, and 4375 kg of HY320 wheat were released to the Canadian Wheat Board for further seed increase under contract. Breeder seed of 57 varieties of cereals, forages, and oilseed crops was distributed to 666 growers.

PUBLICATIONS

Research

Acharya, S. N.; Dueck, J.; Downey, R. K. 1983. Selection and heritability studies on canola/rapeseed for low temperature germination. Can. J. Plant Sci. 63:377-384.

Archibold, O. W.; Hume, L. 1983. A preliminary survey of seed input into fallow fields in Saskatchewan. Can. J. Bot. 61:1216-1221.

Bowes, G. G. 1983. Aspen poplar control with 2,4-D formulations. Can. J. Plant Sci. 63:323-325.

Burgess, L.; Dueck, J.; McKenzie, D. L. 1983. Insect vectors of the yeast *Nematospora coryli* in mustard, *Brassica juncea*, crops in southern Saskatchewan. Can. Entomol. 115:25-30.

Chow, P. M. P.; O'Sullivan, P. A.; Hunter, J. H.; Kirkland, K. J. 1983. Control of barley and wheat in canola with BAS 9052. Can. J. Plant Sci. 63:1099-1102.

Grover, R.; Morse, P. M.; Huang, P. M. 1983. Bioactivity of atrazine in nine Saskatchewan soils. Can. J. Plant Sci. 63:489-496.

Holt, N. W. 1983. Yield and composition of bromegrass–alfalfa as affected by ammonium nitrate and ammonium phosphate fertilizers. Can. J. Plant Sci. 63:169-172.

Holt, N. W.; Winkleman, G. E. 1983. Availability of residual fertilizer phosphorus as measured by bromegrass–alfalfa dry matter and phosphorus yield and by extractable soil phosphorus. Can. J. Plant Sci. 63:173-181.

Hsiao, A. I.; McIntyre, G. I.; Hanes, J. A. 1983. Seed dormancy in *Avena fatua* 1. Induction of germination by mechanical injury. Bot. Gaz. 144:217-222.

Hsiao, A. I.; Smith, A. E. 1983. A root bioassay procedure for the determination of chlorsulfuron, diclofop acid and sethoxydim residues in soils. Weed Res. 23:231-236.

Hsiao, A. I.; Worsham, A. D.; Moreland, D. E. 1983. Leaching and degradation of *dl*-strigol in soil. Weed Sci. 31:763-765.

Hume, L.; Cavers, P. B. 1982. Adaptation in widespread populations of *Rumex crispus* L. as determined using composite diagrams. Can. J. Bot. 60:2637-2651.

Hume, L.; Cavers, P. B. 1983. Resource allocation and reproductive and life-history strategies in widespread populations of *Rumex crispus*. Can. J. Bot. 61:1276-1281.

Hume, L.; Cavers, P. B. 1983. Differences in the flowering requirements of wide-spread populations of *Rumex crispus* L. Can. J. Bot. 61:2760-2762.

Hume, L.; Martinez, J.; Best, K. 1983. The biology of Canadian weeds. 60. *Polygonum convolvulus* L. Can. J. Plant Sci. 63:959-971.

Jain, J. C.; Quick, W. A.; Hsiao, A. I. 1983. ATP synthesis during water imbibition in caryopses of genetically dormant and non-dormant lines of wild oat (*Avena fatua* L). J. Exp. Bot. 34:381-387.

McIntyre, G. I. 1983. Evidence of transpiration-induced curvatures in the rhizome of *Agropyron repens* L. Beauv. Ann. Bot. 51:395-398.

Mortensen, K.; Bergman, J. W. 1983. Cultural variance of *Alternaria carthami* isolates and their virulence on safflower. Plant Dis. 67:1191-1194.

Mortensen, K.; Bergman, J. W; Burns, E. E. 1983. Importance of *Alternaria carthami* and *A. alternaria* in causing leaf spot diseases of safflower. Plant Dis. 67:1187-1190.

Nicholaichuk, W.; Grover, R. 1983. Loss of fall-applied 2,4-D in spring runoff from a small agricultural watershed. J. Environ. Qual. 12:412-414.

Peschken, D. P.; Thomas, A. G.; Wise, R. F. 1983. Loss in yield of rapeseed (*Brassica napus, B. campestris*) caused by perennial sow-thistle (*Sonchus arvensis*) in Saskatchewan and Manitoba. Weed Sci. 31:740-744.

Quick, W. A.; Hsiao, A. I.; Jain, J. C. 1983. Endogenous inorganic phosphate in relation to seed dormancy and germination of wild oats. Plant Sci. Lett. 28:129-135.

Secoy, D. M.; Smith, A. E. 1983. Use of plants in control of agricultural and domestic pests. Econ. Bot. 37:28-57.

Secoy, D. M.; Smith, A. E. 1983. The lineage of lime sulphur as an insecticide and fungicide. Bull. Entomol. Soc. Am. 29:18-23.

Smith, A. E.; Hayden, B. J. 1982. Carry-over of dinitramine, triallate and trifluralin to the following spring in soils treated at different times during the fall. Bull. Environ. Contam. Toxicol. 29:483-486.

Smith, A. E.; Hsiao, A. I. 1983. Persistence studies with the herbicide sethoxydim in prairie soils. Weed Res. 23:253-257.

Smith, A. E.; Milward, L. J. 1983. Comparison of solvent systems for the extraction of diclofop acid, picloram, simazine and triallate from weathered field soils. J. Agric. Food Chem. 31:633-637.

Smith, A. E.; Milward, L. J. 1983. Thin-layer chromatographic detection of the herbicide asulam in soils and the identification of sulphanilamide as a minor soil degradation product. J. Chromatogr. 265:378-381.

Tinline, R. D.; Hunter, J. H. 1982. Herbicides and common root rot of wheat in Saskatchewan. Can. J. Plant Pathol. 4:341-348.

Walker, A; Smith, A. E., et al. 1983. EWRS Herbicide-Soil Working Group: Collaborative experiment on simazine persistence in soil. Weed Res. 23:373-383.

Miscellaneous

Bubar, C. J. 1983. Growth habit and control of wild oats. Agric. Can. Tech. Bull. 20 pp. (revised).

Grover, R. 1983. Transport of wild oat herbicides in the environment. Proceedings Wild Oat Symposium, 18–19 October, Regina, Sask. pp. 119-132.

Hamill, A. S.; Wise, R. F.; Thomas, A. G. 1983. Weed survey of Essex and Kent counties, 1978 and 1979. Agric. Can. Weed Survey Series Publ. 83-1. 134 pp.

Holt, N. W. 1982. Annual canarygrass. Can. Agric. 28(4):18-19.

Hsiao, A. I.; Quick, W. A. 1983. The induction and breakage of seed dormancy in wild oats. Proceedings Wild Oat Symposium, 18–19 October, Regina, Sask. pp. 173-185.

Hunter, J. H. 1983. Cultural control of wild oats. Proceedings Wild Oat Symposium, 18–19 October, Regina, Sask. pp. 43-52.

Ivany, J. A.; Thomas, A. G. 1983. The 1979 weed survey of grain fields in Prince Edward Island. Agric. Can. Weed Survey Series Publ. 83-3. 60 pp.

McIntyre, G. I.; Hsiao, A. I. 1983. The role of water in the mechanism of seed dormancy in wild oats (*Avena fatua* L.). Proceedings Wild Oat Symposium, 18–19 October, Regina, Sask. pp. 187-200.

Mortensen, K. 1983. Biological control of wild oats. Proceedings Wild Oat Symposium, 18–19 October, Regina, Sask. pp. 61-65.

Quick, W. A.; Hsiao, A. I. 1983. The role of phosphorus in wild oat dormancy. Proceedings Wild Oat Symposium, 18–19 October, Regina, Sask. pp. 161-172.

Smith, A. E. 1983. Persistence of wild oat herbicides. Proceedings Wild Oat Symposium, 18–19 October, Regina, Sask. pp. 111-117.

Smith, A. E.; Hsiao, A. I. 1983. Soil persistence of the newly registered herbicide Poast. Canadex 609.

Thomas, A. G. 1983. Field and questionnaire surveys of cereal and oilseed crops in Western Canada. Proceedings Wild Oat Symposium, 18–19 October, Regina, Sask. pp. 17-26.

Thomas, A. G.; Wise, R. F. 1983. Peace River region of British Columbia weed survey of cereal and oilseed crops; 1978, 1979, 1980. Agric. Can. and B.C. Minist. Agric. Food Weed Survey Series Publ. 83-4. 171 pp.

Thomas, A. G.; Wise, R. F. 1983. Peace River region of British Columbia weed survey of forage crops, 1978, 1979 and 1980. Agric. Can. and B.C. Minist. Agric. Food Weed Survey Series Publ. 83-5. 155 pp.

Thomas, A. G.; Wise, R. F. 1983. Weed surveys of Saskatchewan cereal and oilseed crops from 1976 to 1979. Agric. Can. Weed Survey Series Publ. 83-6. 260 pp.

Thomas, A. G.; Wise, R. F.; Hamill, A. S. 1983. Essex and Kent counties weed survey questionnaire data, 1978 and 1979. Agric. Can. Weed Survey Series Publ. 83-2. 47 pp.

Research Station
Saskatoon, Saskatchewan

PROFESSIONAL STAFF

J. R. Hay, B.S.A., M.S., Ph.D., F.W.S.S.A.	Director
R. K. Downey, O.C., B.S.A., M.Sc., Ph.D., F.A.I.C., F.R.S.C.	Assistant Director; Oilseed breeding—canola
R. J. Peters	Administrative Officer

Scientific Support

R. E. Howarth, B.S.A., M.Sc., Ph.D.	Head of Section; Legume bloat—biochemistry
M. J. Bentham, B.Sc., M.Sc.	Computer Systems Manager
D. M. Kichuk,[1] B.F.A., B.A., M.L.S.	Librarian
C. E. Lynn, B.S.A.	Information Officer
H. K. Milne	Computer Systems Programmer
D. T. Spurr, B.Sc., M.Sc., Ph.D.	Statistician
R. E. Underwood	Photographer

Oilseeds

R. K. Downey, O.C., B.S.A., M.Sc., Ph.D., F.A.I.C., F.R.S.C.	Head of Section; Oilseed breeding—canola
A. P. Arthur, B.Sc., M.S., Ph.D.	Oilseed crop insects
L. Burgess, B.Sc., M.Sc., Ph.D.	Oilseed crop insects
D. I. McGregor, B.Sc., M.Sc., Ph.D.	Physiology of *Brassica* spp.
G. A. Petrie, B.A., M.A., Ph.D.	Oilseed crop diseases
G. F. W. Rakow, B.S.A., Ph.D.	Oilseed breeding—canola
G. Séguin-Swartz, B.Sc., Ph.D.	Cytogenetics of *Brassica* spp.
H. Ukrainetz, B.S.A.	Soil fertility
P. R. Verma, B.Sc., M.Sc., Ph.D.	Oilseed crop diseases
D. L. Woods,[2] B.Pharm., M. Phil., Ph.D.	Oilseed breeding—mustard, sunflowers

Cereals

R. D. Tinline,[3] B.A., M.Sc., Ph.D., F.C.S.P.P.	Head of Section; Cereal root diseases
K. L. Bailey, B.Sc., M.Sc.	Cereal root diseases
W. L. Crowle, B.S.A., M.Sc.	Cereals and crop management
L. J. Duczek, B.S.A., M.Sc., Ph.D.	Cereal root diseases
H. Harding, B.Sc., Ph.D.	Cereal root diseases

Forage Crops

B. P. Goplen, B.S.A., M.Sc., Ph.D.	Head of Section; Legume breeding
C. H. Craig, B.A.	Forage crop insects
R. E. Howarth, B.S.A., M.Sc., Ph.D.	Legume bloat—biochemistry
R. P. Knowles, B.S.A., M.Sc., Ph.D., F.A.I.C.	Grass breeding
G. L. Lees, B.Sc., Ph.D.	Legume bloat—plant physiology
J. D. Smith, B.Sc., M.Sc.	Forage and low-temperature diseases

Insect Pest Management

J. F. Doane, B.S.A., M.S., Ph.D.	Head of Section; Insects—ecology and behavior
G. R. F. Davis, B.Sc., M.Sc., Ph.D.	Insects—physiology and nutrition
R. H. Elliott,[4] B.A., Ph.D.	Insecticides
A. B. Ewen, B.A., M.A., Ph.D., F.R.E.S.	Insects—ecology and pathology
R. J. Ford, B.S.A., M.Sc., Ph.D.	Engineering
F. J. H. Fredeen, B.S.A., M.Sc.	Black flies
C. F. Hinks,[5] B.Sc., Ph.D.	Insects—toxicology
M. K. Mukerji, B.Sc., M.Sc., Ph.D.	Insects—management
O. O. Olfert, B.Sc., B.S.A., M.Sc., Ph.D.	Insects—ecology
N. D. Westcott, B.Sc., Ph.D.	Pesticide—chemistry

Scott Experimental Farm

K. J. Kirkland, B.S.A., M.Sc.	Superintendent; Weeds and crop management
S. A. Brandt, B.S.A., M.Sc.	Agronomy

Departures

M. A. Glen, B.A., M.L.S. Deceased 8 August 1983	Librarian
L. G. Sonmor, B.S.A., M.Sc. Retired July 1983	Irrigation

VISITING SCIENTISTS

S. N. Acharya, M.Sc., Ph.D. Canola Council of Canada visiting fellow, 1980–1981; research associate, 1982–1983.	Plant pathology
Zhang Yan Assistant Research Scientist, Shanghai Academy of Agricultural Science, Shanghai, People's Republic of China, 1982–1983.	Plant breeding

Graduate students

D. S. Hutcheson, B.A., B.S.A.	Plant breeding
H. K. Love, B.S.A.	Plant breeding

---

[1] Seconded from Libraries Division, Finance and Administration Branch.

[2] On a Canadian International Development Agency (CIDA) assignment to Njoro, Kenya, from 4 July 1983 to 31 August 1985.

[3] On transfer of work to Waite Agricultural Research Institute, Glen Osmond, South Australia, February 1983 to July 1983, and to Queensland Wheat Research Institute, Toowoomba, Australia, August 1983 to January 1984.

[4] Appointed 11 April 1983.

[5] Appointed 2 May 1983.

INTRODUCTION

This report covers the results of work completed in 1983 at the Saskatoon Research Station and the Scott Experimental Farm, 160 km west of Saskatoon.

Four research programs are conducted. The oilseed, forage crops, and cereal programs include research on breeding, agronomy, and control of diseases, weeds, and insects. We have the major responsibility in the Research Branch for research on rapeseed/canola and mustard. We, along with the Lethbridge and Kamloops stations, are an integral part of the Branch's research program on development of bloat-safe alfalfa. We have a major responsibility for the development of forage grasses for the northern prairies. The cereal program is mainly concerned with reducing losses from root rot in wheat and barley, and with the breeding of utility wheats. The integrated pest management program deals with the development of control systems for problem insects (i.e., grasshoppers, wireworms, black flies) that are not specifically restricted to any one commodity. A major objective in the program is the minimization of our dependence on insecticides for the control of these pests.

The Station was deeply saddened by the untimely death of Marlene A. Glen, librarian. Dr. R.D. Tinline was appointed a Fellow of the Canadian Phytopathological Society. Mr. J. D. Smith received an award at Western Canada Winter Wheat Conference for outstanding contribution in the expansion of knowledge of low-temperature diseases of cereals, legumes, and grasses. Mr. H. Ukrainetz was recipient of the Agronomy Merit Award presented by Western Co-op Fertilizers. Mr. L. G. Sonmor retired after 33 yr service in irrigation agronomy. Dr. C. F. Hinks and Dr. R. E. Elliott joined the staff as entomologists, and D. M. Kichuk became the new librarian. Dr. D. L. Woods was on leave to work on a foreign assignment in Njoro, Kenya. Dr. R. D. Tinline spent most of 1983 in Australia doing research on common root rots.

Previous reports and reprints of publications can be obtained from the Saskatoon Research Station, Research Branch, Agriculture Canada, 107 Science Crescent, Saskatoon, Sask. S7N 0X2.

J. R. Hay
Director

OILSEEDS

Rapeseed/canola

Breeding. Low soil temperature conditions can adversely affect canola emergence and stand establishment. A technique, based on rapid germination of seeds on moist filter paper at 10°C, was developed and used to screen canola genotypes suitable for low temperature propagation. Rapid germination and ability for growth at low temperatures in *Brassica napus* L. and *B. campestris* L. were found to be inherited characteristics. Selection within canola cultivars for rapid germination was successful. However, canola genotypes now available displayed limited variability for germination and seedling vigor at low temperatures. Thus, without bringing in new germ plasm, rapid progress within the populations surveyed could not be expected.

Insects. From time to time the large, purple and green Nuttall blister beetle attacks the foliage and bloom of canola crops. This beetle tends to accumulate in clusters on plants, and often chews off stems and feeds on the severed plant parts on the ground. Because this beetle feeds primarily on caragana, serious attacks on canola usually occur near caragana hedges but not elsewhere in the field. Greater canola production itself is not likely to increase the numbers of this beetle as population size is probably limited by the availability of wild leafcutter bee cells, which are necessary for larval development. Less frequently, a second blister beetle, *Epicauta ferruginea* (Say), may be found in canola crops. This species is rusty brown and smaller than the Nuttall blister beetle, and it feeds almost exclusively on the blossoms. To date its numbers have not been high enough to constitute a problem.

In cooperation with eight agricultural representatives from the Saskatchewan

Department of Agriculture, 27 canola growers in northeastern Saskatchewan each looked after two bertha armyworm pheromone traps. The average number of bertha moths captured during July 1983 was 1.02, or less than one-fifth of that for 1982. Moth counts from pheromone traps in northeastern Saskatchewan during the past 3 yr indicate that counts greater than 15 moths per trap per week during July are necessary before there is any danger of economic numbers of bertha armyworm larvae occurring in the area. The low moth counts obtained in Saskatchewan in 1983 suggest that there is little danger of an economic outbreak of bertha armyworm in 1984.

Diseases. Black leg, *Leptosphaeria maculans* (Desm.) Ces. & de N., was prevalent in the northwestern, northeastern, and central portions of the area under rapeseed/canola cultivation in Saskatchewan. However, as in previous years it was much less common over a large area in the southeastern part of the province. Yield losses were less severe than in 1982.

Temperature, leaf age, time of leaf detachment, and their interactions had a significant effect on the development of white rust, *Albugo candida* (Pers. ex Lev.) Ktze., race 7, on detached leaves of *B. campestris* cv. Torch. A temperature of 18.5°C was calculated to be the optimum for the best disease development. Growth occurred between 9 and 27°C. Unlike intact plants, detached leaves developed pustules on both surfaces. Infection occurred on leaves of all ages, but medium-aged leaves supported the maximum number of pustules, followed by the younger leaves. Leaves detached at the end of a dark period developed more pustules than those detached at the end of a light period.

Weed control. In wheat–canola rotations, control of volunteer wheat is a problem in the canola crops. Postemergence applications of BAS-9052 at 0.3 kg/ha mixed with Atplus 411F (0.5% vol/vol) gave excellent control of volunteer wheat and increased the yield of canola.

Semiautomatic seed counter. A semiautomatic seed counter was developed for counting rapeseed seeds from 1 to 23 sample containers into 1–23 collecting containers. The counter can count and collect either a predetermined number of seeds from each sample or the total number of seeds in each sample. For samples of more than 100 seeds, the count accuracy varied from ±1% to ±2%, depending on the size and shape of the seed. When counting in the predetermined mode with samples of less than 100 small seeds, the count accuracy was reduced to ±3%.

Sunflowers

Insects. During 1983 more than 9000 wild sunflower heads were collected at four dates between 20 July and 25 August at six localities, and at two dates at two other localities in Saskatchewan. The sunflower moth was most abundant in the 20–21 July collection from Carievale and Estevan. The sunflower seed maggot, *Neotephritis finalis* (Loew), was most abundant in collections from Weyburn and Lumsden, collected on 20–21 July and 3–4 August. The banded sunflower moths, *Cochylis hospes* (Wilshm.) and *Cochylis* n.sp., were most abundant in the collections from Drinkwater and Carievale, collected on 3–4 August and 16–17 August.

Most of the cultivated sunflowers did not begin blooming until 1 August. Thus the banded sunflower moth, which was the most abundant species during August, was the major pest attacking the commercial crop.

FORAGES

Grasses

Long-term storage of grass seeds. Seeds of crested wheatgrass, *Agropyron cristatum* (L.) Gaertn., intermediate wheatgrass, *A. intermedium* (Host.) Beauv., and smooth bromegrass, *Bromus inermis* Leyss., were stored for 20 yr under various conditions. Viability was inversely related to the storage temperature. At −7 and −18°C, viabilities of 80–90% were obtained after 20 yr storage. Drying seed at 60°C for 7.5 h prior to storage gave little improvement over storage of undried seed with 8% moisture. Storage in plastic bags was as good as in glass jars with screw-top lids, although plastic bags were less effective in excluding moisture. It was concluded that adequate germination for reproduction of strains could be obtained from 25 to 30 yr of storage.

Isolation requirement in perennial grasses. Interpollination of 0.125 ha seed plots separated by 50 m was studied for 4 yr, using genetic markers for three grasses. Average contamination of smooth bromegrass was 2.4% in one direction and 4.6% in the opposite direction. Average contamination for crested wheatgrass was 1.2% and for reed canarygrass 3.9%. Contamination was more severe in the border two rows, being 6.7% and 9.4% for bromegrass, 5.5% for crested wheatgrass, and 9.4% for reed canarygrass. These tests support current regulations requiring 50-m isolation for the production of certified seed.

Insects. Two peaks in the population of the adult bromegrass seed midge, *Contarinia bromicola* (Marikovskij & Agafonova), were observed. The first occurred at bromegrass heading time in early June and the second about 20–25 days later at bromegrass flowering. Parasitism by a species of *Tetrastichus* (Eulophidae) varied from 30% to 75%. Carbofuran (0.14 kg/ha) or dimethoate (0.56 kg/ha), applied just before emergence of adult midges at flowering time, significantly reduced the first generation of midges and parasites resident in the plants.

Legumes

Legume pasture bloat. A major goal of the legume forage program is the development of a bloat-safe alfalfa cultivar by selection for slower initial rate of digestion (IRD). A test of IRD heritability has indicated the need for progeny testing to ensure control of environmental variation. A field nursery for the third cycle of IRD selection, which has been established, and final selections from this nursery will be based on progeny tests. The first cycle selections for slow and fast IRD traits were fed to sheep in 1983 at the Lethbridge Research Station and showed the expected difference in rumen metabolism in vivo.

Predisposition to bloat. In a cooperative project with the Kamloops, Lethbridge, and Vancouver research stations, rumen contents from the dorsal sac were examined before alfalfa ingestion to determine factors that predispose cattle to pasture bloat. Chlorophyll concentration, buoyancy of particulate matter, and rates of gas production were significantly higher in cattle that subsequently bloated than in those that did not. Higher chlorophyll in bloat cases indicated accumulation of suspended chloroplast particles in the dorsal sac. The higher fermentation rates (in the presence of glucose) suggested that the latent capacity for gas production was due to microbial colonization of suspended feed particles. In short, the microbial colonization and retention of particulate matter provided active inocula for promoting rapid legume digestion. Consequently, gas production was enhanced when feeding commenced, but the fermentation gases were trapped by the buoyant, frothy ingesta, resulting in the condition of pasture bloat.

CEREALS

Wheat and barley

Common root rot. Two populations of *Cochliobolus sativus* (Ito & Kurib.) Drechsl. ex Dastur were examined for the presence of differentially fertile strains. A "random" population of 65 isolates from widely separated geographic areas in Saskatchewan were intercrossed; a second group of 98 isolates from a single field were intercrossed also. The same general pattern emerged in both groups. In compatible matings, some isolates were generally fertile, i.e., ascospores were produced in essentially all crosses involving them, whereas others were usually infertile in that crosses involving them rarely progressed beyond the protothecial stage. The majority of isolates fell between these two extremes. The operation of two independent genetic factors, one governing ascocarp formation and one controlling ascus-ascospore formation has been postulated.

Herbicides and common root rot of wheat. The intensity of common root rot caused by *C. sativus* was not affected by the application of 2,4-D amine to wheat plants at different growth stages, or to leaves or roots in the greenhouse. In field tests in Saskatchewan, plots treated with several postemergence herbicides and untreated plots had comparable levels of the disease. The herbicides were amines and esters of 2,4-D and MCPA; barban, benzadox, bromoxynil, and MSMA; and mixtures of bromoxynil, dicamba, dichloroprop, linuron, and monolinuron with 2,4-D and MCPA. Although root rot was increased, often significantly, following the soil incorporation of the preemergence herbicides triallate and trifluralin, this increase was due to the associated incorporation practice rather than to the chemicals. The nature of disease enhancement resulting from the disturbance of the soil was not resolved.

Common root rot in Brazil. In cooperation with Centro Nacional de Pesquisa de Trigo

(EMBRAPA), Passo Fundo, Brazil, the effect of cultivation systems on the intensity of common root rot and take-all in wheat (*Triticum aestivum* L.) fields was determined in Rio Grande do Sul, Brazil. Common root rot occurred in all surveyed fields. Its intensity was high in fields cropped annually to wheat and in those maintained out of wheat for 1.5 yr, regardless of the other crops grown. The disease was much less intense in fields that had been left fallow for 3 or 4 yr, or that were planted to wheat for the first time. *C. sativus* was the dominant pathogen isolated from lesioned wheat roots. Take-all occurred in about 30% of the fields annually cropped to wheat or that had been either left fallow or planted to a non-host crop such as flax, lupine, oats, or rapeseed for 1 yr. Take-all was not found in wheat following 2 yr, or more, of oats, fallow, or a combination of fallow and a non-host crop. The average disease ratings in 1980 and 1981 were 60% and 71%, respectively.

Fungicides for control of common root rot in wheat. The efficacy of triadimenol, imazalil, and nuarimol for control of common root rot in spring wheat was determined in a 3-yr trial at three locations in Saskatchewan. All three chemicals, each applied to seed at rates ranging from 0.1 to 0.6 g/kg, significantly reduced the severity of root rot on the cultivars Cypress and Neepawa. In all 3 yr a dose-response was apparent in both cultivars at all test locations. The degree of disease reduction varied greatly among locations, cultivars, and fungicides. Disease control usually was better in Neepawa than in Cypress. Generally, nuarimol gave lower disease ratings than did triadimenol or imazalil. The significant reduction in disease did not produce significantly higher yields; in most cases yields were reduced. Significant interactions occurred between cultivars and locations, and between fungicides and locations. The reduced yields possibly resulted from some phytotoxicity of the fungicides.

Fungicides for control of common root rot in barley. Nuarimol, etaconazole, and fenapanil, applied as seed treatments to barley, resulted in a significant reduction in common root rot symptoms at four locations in Western Canada. This reduction in disease symptoms was not accompanied by an increase in yield, and at some higher rates of chemical application grain yields were significantly reduced. Reduced seedling emergence and seedling growth indicated that most fungicides were phytotoxic to Gateway barley at some of the rates being used. Etaconazole, trivax, and triadimenol were the most effective chemicals for the control of loose smut.

Cereal disease survey. Septoria leaf and glume blotch was widespread in central and northern regions. It was particularly severe in northeastern Saskatchewan where above average precipitation in early summer favored disease development. The amount of loss caused by Septoria was difficult to assess because of the severe damage caused by the orange wheat blossom midge in the same area. In the southern region, tan spot was the most serious leaf disease of wheat.

Leaf rust of wheat in Saskatchewan was recorded in trace or slight amounts in about 13% of the fields. Stem rust was not seen. Common root rot was present in all fields surveyed. It appeared to be slightly less severe than in 1982, which was an above-average year. Ergot was noted in about one-third of the wheat fields. Loose smut of wheat was noted once. The hot weather in August favored the development of "white heads" in wheat in the southern areas. The cause was mainly physiological but root diseases were probably involved in some cases.

A survey of Crop Districts 5–9 was conducted in 1982 and 1983 to determine the presence and severity of leaf stripe in commercial barley fields. In 1982, 105 fields, which included 54 two-row and 51 six-row fields, were entered and no leaf stripe was detected. In 1983, 75 fields, which included 25 two-row and 50 six-row fields, were entered and the disease was found in trace amounts in two fields; one of a two-row barley (Crop District 7) and the other of a six-row barley (Crop District 9).

Cereal quality. Test weight and kernel weight of five North American amber durum wheat cultivars were decreased with increasing N fertilizer, but semolina milling yield was not affected. Protein levels increased for all cultivars at each level of N fertilizer, but kernel hardness, as measured by semolina granulation was not affected. Gluten strength and gluten protein solubility in lactic acid were not influenced by level of N fertilizer. Changes in cooking quality were attributed to increased levels of protein at high N fertilization levels.

INTEGRATED PEST MANAGEMENT

Grasshoppers

Nosema survey. In 1981, the grasshopper pathogen *Nosema locustae* was found to occur naturally in 10 different species of grasshoppers at several locations in Saskatchewan south of latitude 53°N, and from Yorkton in the east to near the Alberta border in the west. Usually only 1–3% of the grasshoppers collected contained the pathogen, but in west-central Saskatchewan about 10% of the grasshoppers were infected. Generally, the pathogen was found more frequently in omnivorous grasshoppers than in those that are primarily grass feeders.

Black flies

Economic assessment of black flies in Saskatchewan. Major increases in the breeding of *Simulium luggeri* commenced in the Saskatchewan River in 1968, soon after the appearance of aquatic weeds, which afforded attachment sites for the larvae. Damaging outbreaks commenced in 1975 and have been a serious concern of livestock producers ever since. This black fly, which produces several generations each summer, disperses widely and attacks most mammalian species, including humans. The adults swarm around the heads of cattle, causing hyperactivity and serious economic losses for livestock producers.

The most destructive outbreaks occurred in 1978 when black flies spread into about 38 000 km^2 of east-central Saskatchewan and caused measurable losses in about 57 000 km^2. Losses to beef producers in 1978 were estimated to exceed $2.9 million. This included unrealized weight gains, delayed conceptions, fatalities, replacements of debilitated bulls, increased stress-related diseases, injuries, and veterinarian services, fence repairs, and supplementary feeding. Losses to dairy producers were estimated to exceed $57 000. Milk production from severely affected cows did not return to normal until new lactation cycles commenced, sometimes several months after outbreaks ceased in the fall.

Injections of methoxychlor into the Saskatchewan River at appropriate times and places have generally prevented the reoccurrence of major outbreaks since 1978, although relatively minor annual outbreaks continue to occur.

Orange wheat blossom midge

Damage assessment. An outbreak of the orange wheat blossom midge occurred over 140 000 ha in northeastern Saskatchewan in 1983. This species has not been previously reported in the province at economic levels. In the most severely affected area about 50% of the wheat kernels were destroyed. In the peripheral area, the percentage of kernel infestation ranged from 0 to 10. The potential for severe damage in 1984 is extremely high. Biological and control studies have been initiated.

Insecticide chemistry

Residue analysis. Carbofuran, 3-ketocarbofuran, and 3-hydroxycarbofuran were extracted from acid-digested rapeseed plants with methylene chloride. The concentrated methylene chloride extract was first chromatographed on a carbon/attaclay/silica, then on an acid alumina/Florisil/silica gel column to provide fractions containing carbofuran, 3-ketocarbofuran, and 3-hydroxycarbofuran. Each fraction was analyzed by gas chromatography with a nitrogen–phosphorus detector, using an Apiezon L column. In the 0.03–5 ppm range, the efficiency of recovery averaged 85%. Maximum residues of carbofuran, from an in-furrow application at time of seeding, were found in plants collected 6–8 days after seeding. The concentration of the metabolites 3-ketocarbofuran and 3-hydroxycarbon were maximum at approximately 11 days after seeding.

PUBLICATIONS

Research

Acharya, S. N.; Dueck, J.; Downey, R. K. 1983. Selection and heritability studies on canola/rapeseed for low temperature germination. Can. J. Plant Sci. 63:377-384.

Ackigoz, E.; Knowles, R. P. 1983. Long-term storage of grass seeds. Can. J. Plant Sci. 63:669-674.

Bailey, K.; MacNeill, B. H. 1983. Virulence of *Erysiphe graminis* f. sp. *tritici* in southern Ontario in relation to vertical genes for resistance in winter wheat. Can. J. Plant Pathol. 5:148-153.

Burgess, L. 1983. Damage to rapeseed plants by two species of blister beetles (Coleoptera: Meloidae). Can. Entomol. 115:875-876.

Burgess, L.; Dueck, J.; McKenzie, D. L. 1983. Insect vectors of the yeast *Nematospora coryli* in mustard, *Brassica juncea*, crops in southern Saskatchewan. Can. Entomol. 115:25-30.

Chow, P. N. P.; O'Sullivan, P. A.; Hunter, J. H.; Kirkland, K. J. 1983. Control of barley and wheat in canola with BAS 9052. Can. J. Plant Sci. 63:1099-1102.

Craig, C. H. 1983. Seasonal occurrence of *Lygus* spp. (Heteroptera: Miridae) on alfalfa in Saskatchewan. Can. Entomol. 115:329-331.

Curry, P. S.; Knowles, R. P.; Waddington, J. 1983. Seasonal occurrence and chemical control of the bromegrass seed midge, *Contarinia bromicola* (Diptera: Cecidomyiidae), in Saskatchewan. Can. Entomol. 115:75-79.

Davis, G. R. F. 1982. Growth of larvae of *Tenebrio molitor* L. fed diets containing penicillic acid, aflatoxin B_1, ochratoxin A, or rubratoxin B at three dietary protein levels. Arch. Int. Physiol. Biochim. 90:297-300.

Davis, G. R. F.; Schiefer, H. B. 1983. Effects of dietary diacetoxyscirpenol on growth of larvae of the yellow mealworm, *Tenebrio molitor* L. Comp. Biochem. Physiol. 74C:167-171.

Dexter, J. E.; Crowle, W. L.; Matsuo, R. R.; Kosmolak, F. G. 1982. Effect of nitrogen fertilizer on the quality characteristics of five North American amber durum wheat cultivars. Can. J. Plant Sci. 62:901-912.

Diehl, J. A.; Kochhann, R. A.; Tinline, R. D. 1983. Sistemas de cultivo sobre a podridão comum de raizes e mil-do-pẽ do trigo. Pesq. Agropec. Bras., Brasilia 18:235-241.

Downey, R. K. 1983. The origin and description of the *Brassica* oilseed crops. Pages 1–20 *in* Kramer, J. K. G.; Sauer, F. D.; Pigden, W. J., eds. High and low erucic acid rapeseed oils. Production, usage, chemistry, and toxicological evaluation. Academic Press, Toronto, Ont.

Duczek, L. J. 1983. Populations of mycophagous amoebae in Saskatchewan soils. Plant Dis. 67:606-608.

Ewen, A. B. 1983. Extension of the geographic range of *Nosema locustae* (Microsporida) in grasshoppers (Orthoptera: Acrididae). Can. Entomol. 115:1049-1050.

Fredeen, F. J. H. 1983. Trends in numbers of aquatic invertebrates in a large Canadian river during four years of black fly larviciding with methoxychlor (Diptera: Simuliidae). Quaest. Entomol. 19:53-92.

Harding, H.; Tinline, R. D. 1983. The existence of differentially fertile strains in two populations of *Cochliobolus sativus*. Can. J. Plant Pathol. 5:17-20.

Howarth, R. E.; Goplen, B. P. 1983. Improvement of forage quality through production management and plant breeding. Can. J. Plant Sci. 63:895-902.

Knowles, R. P. 1983. Tests of isolation requirement in three perennial grasses. Can. J. Plant Sci. 63:927-933.

Knowles, R. P.; Kilcher, M. R. Crested wheatgrass. Agric. Can. Contrib. 1983-18E. 18 pp.

Lee, Y. W.; Westcott, N. D. 1983. Direct analysis of carbofuran and its carbamate metabolites in rapeseed plants by nitrogen–phosphorus detector gas chromatography. J. Agric. Food Chem. 31:92-96.

Majak, W.; Howarth, R. E.; Cheng, K.-J.; Hall, J. W. 1983. Rumen conditions that predispose cattle to pasture bloat. J. Dairy Sci. 66:1683-1688.

Major, D. J.; Brown, D. M.; Bootsma, A.; Dupuis, G.; Fairey, N. A.; Grant, E. A.; Green, D. G.; Hamilton, R. I.; Langille, J.; Sonmor, L. G.; Smeltzer, G. C.; White, R. P. 1983. An evaluation of the corn heat unit system for the short-season growing regions across Canada. Can. J. Plant Sci. 63:121-130.

McGregor, D. I.; Mullin, W. J.; Fenwick, G. R. 1983. Review of analysis of glucosinolates. Analytical methodology for determining glucosinolate composition and content. J. Assoc. Off. Anal. Chem. 66:825-849.

Moore, K. C.; Davis, G. R. F. 1983. Bertha armyworm (*Mamestra configurata*), a sensitive bioassay organism for mycotoxin research. J. Invert. Pathol. 42:413-414.

Olfert, O. O.; Mukerji, M. K. 1983. Effects of acute simulated and acute grasshopper (Orthoptera: Acrididae) damage on growth rates and yield of spring wheat (*Triticum aestivum*). Can. Entomol. 115:629-636.

Piening, L. J.; Duczek, L. J.; Atkinson, T. G.; Davidson, J. G. N. 1983. Control of common root rot and loose smut and the phytotoxicity of seed treatment fungicides on Gateway barley. Can. J. Plant Pathol. 5:49-53.

Reid, W. S.; Buckley, D. J.; Downey, R. K. 1983. A semi-automatic seed counter. J. Agric. Eng. Res. 28:89-95.

Tinline, R. D.; Hunter, J. H. 1982. Herbicides and common root rot of wheat in Saskatchewan. Can. J. Plant Pathol. 4:341-348.

Verma, P. R. 1983. Effect of triadimenol, imazalil, and nuarimol seed treatment on common root rot and grain yields in spring wheat. Can. J. Plant Pathol. 5:174-176.

Verma, P. R. 1982. Temporal progression of common root rot [*Cochliobolus sativus*] lesions on subcrown internodes of wheat and barley cultivars. Can. J. Plant Pathol. 4:349-352.

Verma, P. R.; Spurr, D. T.; Petrie, G. A. 1983. Influence of age, and time of detachment on development of white rust in detached *Brassica campestris* leaves at different temperatures. Can. J. Plant Pathol. 5:154-157.

Miscellaneous

Burgess, L. 1983. How flea beetle pests of canola crops overwinter. Canadex 622.149.

Ewen, A. B.; Mukerji, M. K. 1982. A new look at an old method of grasshopper control. Can. Agric. 27(3):42-43.

Kasha, K. J.; Kott, L.; Séguin-Swartz, G. 1982. Genetic stability of haploid cell cultures. Proceedings of the 5th International Congress Plant Tissue Cell Culture. Tokyo, Japan. pp. 405-408.

Klassen, A. J. 1982. Westar, a new improved canola variety. Canadex 149.34.

Knowles, R. P. 1983. Crested wheatgrass response to deep seeding. Canadex 127.22.

Mukerji, M. K.; Braun, M. P. 1983. Grasshopper outbreak forecast for the prairie provinces. Canadex 620.

Séguin-Swartz, G. 1983. Anther culture, a breeding tool for rapeseed–canola improvement. Can. Agric. 29(1):25-27.

Smith, J. D. 1983. *Fusarium nivale* (*Gerlachia nivalis*) from cereals and grasses: Is it the same fungus? Can. Plant Dis. Surv. 63:25-26.

Research Station
Swift Current, Saskatchewan

PROFESSIONAL STAFF

D. M. Bowden,[1] B.S.A., M.S.A., Ph.D	Director
A. W. Strachan	Administrative Officer
G. E. Parker, B.S.A.	Information Officer

Analytical Services

G. E. Winkleman, B.Sc.	Head of Section; Chemist
C. T. Lund[2]	Computer Systems Administration
L. L. Matton,[3] B.Comm.	Systems Analyst
K. E. Wilton,[4] B.A., M.L.S.	Librarian

Cereal Production and Utilization

T. F. Townley-Smith,[5] B.S.A., M.Sc., Ph.D.	Head of Section; Cereal breeding
J. M. Clarke, B.Sc.(Agr.), M.Sc., Ph.D.	Harvest physiology
R. M. De Pauw, B.A., M.Sc., Ph.D.	Wheat breeding
K. E. Dunkelgod, B.S., M.S., Ph.D.	Turkey nutrition
D. G. Green, B.S.A., M.S., Ph.D.	Cereal physiology
T. N. McCaig, B.Sc., M.Sc., Ph.D.	Quality physiology
J. G. McLeod, B.Sc.(Agr.), M.Sc., Ph.D.	Rye breeding
R. E. Salmon, B.S.A., M.S.A., Ph.D.	Turkey nutrition

Engineering

W. Nicholaichuk, B.E., M.Sc., Ph.D.	Head of Section; Hydrology
D. W. Campbell, B.E., M.Sc., Ph.D.	Energy
F. B. Dyck, B.E., M.Sc.	Equipment design
Y. W. Jame, B.Sc., M.Sc., Ph.D.	Irrigation
N. B. McLaughlin, B.Sc., M.Sc., Ph.D.	Equipment design
H. Steppuhn, B.Sc., Ph.D.	Subsurface hydrology
M. A. Stumborg,[6] B.E.	Energy
S. Tessier, B.Sc.(Eng.), M.Sc.	Tillage

Forage Production and Utilization

T. Lawrence,[7] B.S.A., M.Sc., Ph.D.	Head of Section; Grass breeding
N. W. Holt,[8] B.S.A., Ph.D.	Pasture management
P. G. Jefferson, B.Sc.(Agr.), M.Sc.	Legume breeding and physiology
J. E. Knipfel, B.S.A., M.Sc., Ph.D.	Ruminant nutrition
J. Looman,[9] B.Sc., M.Sc., Ph.D.	Range ecology

Soils and Environment

C. A. Campbell, B.S.A., M.S.A., Ph.D.	Head of Section; Soil chemistry and fertility
V. O. Biederbeck, B.S.A., M.Sc., Ph.D.	Soil microbiology
D. W. McAndrew,[10] B.Sc., M.Sc., Ph.D.	Soil fertility
A. J. Leyshon,[11] B.Sc., M.Sc.	Forage fertility
R. P. Zentner, B.S.A., M.Sc., Ph.D.	Economics

Departures

W. L. Pelton, B.S.A., M.S.A., Ph.D. Transferred to Prairie Regional Headquarters, 14 August 1983	Director
H. R. Davidson, B.Sc., Ph.D. Transferred to Pacific Regional Headquarters, 15 August 1983	Agrometeorology

VISITING SCIENTISTS

D. Demars, B.Sc., M.Sc., Ph.D. Management training assignment to 30 June 1983, Research Branch Headquarters	Physics

---

[1] Transferred from Prairie Regional Headquarters, 15 August 1983.

[2] Seconded from Systems and Consulting Directorate, Finance and Administration Branch.

[3] Seconded from Libraries Division, Finance and Administration Branch.

[4] On leave without pay from 27 May 1983.

[5] On transfer of work to Commonwealth Scientific and Industrial Research Organization (CSIRO), Canberra, Australia, to 30 July 1983.

[6] On educational leave, University of Saskatchewan, Saskatoon, to 31 May 1983.

[7] On transfer of work to DSIR, Palmerston North, New Zealand, 1 September 1983 to 31 August 1984.

[8] Transferred from Indian Head Experimental Farm, 1 September 1983.

[9] Seconded to Canadian International Development Agency (CIDA), Islamabad, Pakistan, from 10 October 1983 to 14 December 1983.

[10] Appointed on 7 March 1983.

[11] On educational leave, University of Saskatchewan, from September 1983 to May 1987.

INTRODUCTION

The Swift Current Research Station conducts a research program with a broad area of interest, although centered in the Palliser Triangle of the Canadian Prairies. Improvements in cereal and forage cultivars and technology to increase production and utilization efficiency are accomplished through a multidisciplinary approach involving plant breeding, plant physiology, agronomy, soil and water management, salinity control, nutrition, agrometeorology, agricultural engineering, and energy.

Of particular significance in results attained this year were those from analyses of 12 yr of data from a long-term crop rotation study. Valuable information on economics, and energy efficiency of different cropping systems was obtained.

Dr. N. Holt transferred from the Indian Head Experimental Farm to assume leadership of the pasture management aspects of the forage program.

This report contains only brief summaries of research completed in 1983. More detailed information can be obtained from the publications listed at the end of this report, from *Research hi-lights* published by the Station, or from individual scientists. Requests and correspondence should be addressed to the Research Station, Research Branch, Agriculture Canada, Box 1030, Swift Current, Sask. S9H 3X2.

D. M. Bowden
Director

CEREAL PRODUCTION AND UTILIZATION

Common wheat

Leader, a hard red spring wheat licensed in 1981, has moved rapidly into commercial production. In 1983, it was sown on 17.5% of the area sown to cultivars with resistance to the wheat stem sawfly (*Cephus cinctus* Norton). Leader is the first hard red spring wheat cultivar that combines resistance to the wheat stem sawfly with a long seed dormancy period.

HY320, a semihard red spring wheat, is being test-marketed as a potential cultivar to launch a new class of wheat for Canada. The quality of HY320 is similar to that of American Hard winter ordinary and Australian standard white wheats. Each of the three end-use suitability factors, namely, kernel hardness, protein content, and gluten strength, tend to be at a medium level. HY320, a semidwarf wheat, has averaged 30% more grain yield than the widely adapted hard red spring wheat cultivar Neepawa.

Drought physiology

Water retention capability of excised leaves of the two *Triticum aestivum* L. cultivars (Canuck and Pitic 62), and two *T. turgidum* var. *durum* L. cultivars (Hercules and Pelissier) was studied in field and controlled environment-grown plant material. There was a significant genotype × environment interaction in Pitic 62 but not in the other three cultivars. The water retention capability of Pitic 62 leaves was greater in the controlled environment than in the field environment. The difference was not caused by different stomate numbers under the two environments.

Laboratory germination rates in D-mannitol solutions (osmotic potential 1.5 MPa) and field emergence rates at two planting dates of 13 red and three white wheat (*T. aestivum* L.) cultivars were compared. No consistent relationship between laboratory and field rankings of either total germination or germination rate was found.

Protein levels in broiler chicken diets

Starter and finisher diets of varying protein contents were compared in an experiment involving 1650 broiler chickens. Weight gains to 4 wk improved with increasing protein level (up to 242 g/kg) in starter diets and the differences were maintained to 8 wk. Feed efficiency to 4 wk but not 8 wk improved with increasing starter protein content. Carcass fleshing, grades, and breast meat yield at slaughter increased with higher starter protein. Weight gains from 4 to 8 wk were not significantly affected by finisher protein levels ranging from 166 to 227 g/kg, but feed efficiency of males was improved when the diet contained 189 g/kg, or more. Higher protein levels in finisher diets decreased carcass skin and abdominal fat yields, and increased breast meat and total meat yields.

Energy-to-protein ratios in diets for turkey broilers

Two experiments involving 1300 Small White turkeys were conducted using diets with ratios of true metabolizable energy-to-protein of 45.1, 47.4, 57.6, 60.5, and 67.0 kJ/g (10.75, 11.4, 13.8, 14.5, and 16.0 kcal/g), changing at 3-wk intervals. These diets resulted in more rapid growth than diets with wider energy-to-protein ratios. Turkeys of one strain grew more rapidly and utilized feed more efficiently, but they deposited carcass fat more slowly than turkeys of another strain. Increasing the energy-to-protein ratio did not improve carcass finish but did reduce the yields of thigh meat and breast meat per kilogram eviscerated carcass weight.

Nutritive value of canola meals

Prepress solvent-extracted canola meals of the cultivars Candle, Altex, and Regent, and expeller-processed Candle meal were analyzed for crude protein (N × 6.25), ether extract, glucosinolates, true metabolizable energy (TME), amino acids, and amino acid availability. Except for higher protein content of Regent meal and increased ether extract and TME content of expeller over prepress solvent-processed meals, the samples were similar in composition and amino acid availability. The TME values of the prepress solvent meals ranged from 10.2 to 10.6 kJ/g (2.44 to 2.54 kcal/g) dry matter compared with 11.4 kJ/g (2.72 kcal/g) for expeller-processed meal.

True metabolizable energy assay

Three experiments were conducted to determine the effect of excreta collection periods of 24–48 h on the true metabolizable energy (TME) values of ground wheat, soybean meal, and canola meal when determined with adult Single Comb White Leghorn roosters. A collection period of 24 h was sufficient for wheat, but the TME assay values of both soybean and canola meals were significantly reduced by collection times of 28 h, or longer. Because TME values of ground wheat, soybean, and canola meal, determined individually, satisfactorily predicted the TME value of a mixture of equal parts of each, it was concluded that they are additive.

ENGINEERING

Energy research and development in agriculture and food (ERDAF)

(The results reported in this section are from research carried out under make-or-buy contracts with other agencies in which research scientists from the Swift Current Research Station are supervisory scientific authorities.)

Liquid fuels. Canola oil can be used successfully as an emergency farm fuel for only a short duration of time unless the oil can be refined to meet engine specifications. It was found that after 200 h of operation, problems of carbon deposits do arise. Refined and degummed R500 (high erucic) oil cannot be recommended, because injection nozzle failures occur after only 40 h of operation. Other problems with canola oil are associated with low temperature and viscosities, stability, emissions, nitrogen oxides, oxidation, and wearing characteristics. Expelling canola oil with a press on a farm-scale is not suitable because of durability and efficiency problems.

To produce alcohols in a newly developed two-phase system of fermentation and alcohol extraction, activated charcoal was found to be the most efficient adsorbant for a variety of alcohols from dilute aqueous solution. Heptanol was effective for butinol removal. Using this technique, removal systems would be operated in a continuous mode. Further work is required to refine the methodology prior to industrial application.

Conservation. A prototype heat exchanger was developed, installed in a swine barn, and operated under winter conditions as low as –40°C. The operating characteristics determined for the exchanger and effectiveness of using a rock bed as a heat sink and periodic flow heat exchanger are suitable to be utilized for farm building design purposes by the Canada Plan Service.

Instrumentation. A review of literature and initial development of humidity sensors indicated titania glass exhibited a marked change in resistance with humidity. This device, if developed, would be useful to evaluate grain storage conditions prior to loss due to spoilage. However, sensitivity of the glass to moisture and other effects such as temperature restricts development of the sensor until further fundamental research is carried out.

Agricultural engineering research and development (AERD) in mechanization control engineering

(The results reported in this section are from research carried out under make-or-buy contracts with other agencies in which research scientists from the Swift Current Research Station are supervisory scientific authorities.)

The University of Saskatchewan developed sensors for grain harvesters to measure (*i*) the air flow on the sieves, (*ii*) cracked grain in the clean grain, (*iii*) grain left in the head, and (*iv*) mass flow and composition of tailings. The ultimate objective is to automatically control performance of a combine harvester. The sensor for measuring grain left in the head looks particularly promising and application for a patent is under way.

A prototype of an intrinsically safe grain temperature monitoring system to be used in granaries has been developed by Baker Engineering, Edmonton. Further development is needed to make it a marketable product.

Versatile Noble developed a fold-up hoe drill with a pneumatic seed and fertilizer delivery system. This is an example of a new generation of air seeders coming on the market. The company has also developed a banding attachment for the hoe drill, which places the seed about 2.5 cm above and to the side of the fertilizer.

Boron salinity survey of irrigation projects in Saskatchewan

In 1982, the Summer Youth Employment Program undertook a project to survey 29 surface, groundwater, and effluent irrigation projects in Saskatchewan for boron (B) and salinity. For most locations, B toxicity should be of no concern, because it was within acceptable limits. However, at two locations, plant B concentrations were 300 g/g; at three others it was 100 g/g. At all locations the concentration of B in the soil paste extract was 1.0 g/g soil, a level generally considered nontoxic. At only two locations were significant levels of B found in irrigation waters (1.0 mg/L).

For most locations, total salts in the irrigation water and in the soil were low. However, at a few locations irrigation waters contained a salt level of 2000 mg/L. Management and adequate drainage have prevented significant salt buildup in these soils. At four locations the mean electrical conductivity (EC) for the soil profile was 7.0 dS/cm; at seven other locations the mean EC was 1.5 dS/cm. At present, total salts seem to be more of a problem than B toxicity in the type of irrigation systems and soils studied. Remedial measures such as improved drainage and irrigation scheduling to reduce salt accumulation in the soil will also reduce the potential for B toxicity.

Equipment development

A precision space seeder has been developed for planting early generation research nurseries. The seeder has four rows of space seeding separated by rows of winter wheat and a "spreader" row on each side of the plot.

A trailing clipper attachment for swathers has been developed for snow trapping. Preliminary testing was successful and indicates that a denser barrier can be created with the clipper, particularly in lighter, shorter crops.

A laboratory malter was developed for the Winnipeg Research Station for testing the malting quality of barley samples. The device features controlled temperature and programable steep and air cycles. It can process more than 200 barley samples in one batch.

An on-board weighing system installed in a combine hopper speeds up collection of yield data on field-sized plots. It features a strain gage load cell with electronic readout and data storage (Omni Data Polycorder) and push button control of the collecting and dumping functions.

FORAGE PRODUCTION AND UTILIZATION

Comparative performance of some native and introduced grasses in southern Saskatchewan

The performance of selected native grass species was poor compared to that of certain adapted, introduced, and domesticated grasses. Of 12 grass species native to Canada and northern USA, seven showed poor initial establishment. Subsequent winterkill eliminated them. Of the five surviving native grass species, only two attained a fair forage yield compared to those of five domesticated grasses, and then only after the 3rd or 4th yr of age. Most of the native species showed limited competition with weeds. Nutrient content, particularly crude protein, of the native grasses was not sustained as well as that in some of the tame grasses with advancing seasonal growth stages.

Water meal, *Wolffia arrhiza* (Lemnaceae), in Saskatchewan

Wolffia arrhiza, an addition to the flora of Canada, was found in Saskatchewan in 1981 in a slough north of Pierceland. Further surveys in 1981 and 1982 revealed it in five additional localities. This is the first report of the species in North America.

The vegetation of the Canadian Prairie Provinces, the woody vegetation

In this study the shrub communities of the dryland habitats are described. Dryland shrub communities usually form transitions between the various grasslands and woodlands. Well-developed communities are shown to be closely related to similar communities of Eurasia, and can be placed with these communities in the class group Rubo-Rosea. One class with 2 orders, 4 alliances, 14 associations, and 12 subassociations, and several variants and unclassified communities are recognized and described.

SOILS AND ENVIRONMENT

Results from the first 12 yr of a long-term crop rotation study in southwestern Saskatchewan

The Swift Current long-term crop rotation study is being analyzed and the findings published. So far, six papers have been accepted for publication. The findings have been important and exciting and this study is already being acclaimed by researchers everywhere as being one of the best of its kind.

Nitrate-N distribution in soil and N uptake by the plant. The distribution of NO_3-N in the soil, and N uptake by the crop during the first 12 yr of a long-term rotation study at Swift Current, Sask., were studied. A considerable amount of NO_3-N appeared to be leached beyond the rooting zone of the cereal crop in years of above average precipitation and also in some relatively dry years with heavy spring rains. Thus, leaching of NO_3-N seemed to occur even under continuous wheat rotations. At all times there was considerable NO_3-N situated at the 60- to 120-cm depth. In wet years, N uptake by the plants reduced the amount of NO_3-N located in the subsoil, but in dry years the amount of NO_3-N in the subsoil remained higher throughout the growing season. The latter could result in groundwater pollution, especially if such a soil was fallowed the next year. Fall rye (*Secale cereale* L.) made more efficient use of mineral N than spring-sown crops. In dry years, more NO_3-N persisted in the root zone of N-fertilized wheat than in the root zone of unfertilized wheat, but in wet and average years there was little difference due to N application. The average rate of net NO_3-N production in fallow land from spring thaw to freeze-up (166 days) was 107 kg/ha. Values ranged from about 60 to 175 kg/ha, with the lowest values being obtained during very dry or very wet years. The quantity of mineralized N (kg/ha) between spring thaw and freeze-up was related to precipitation (millimetres) by the following equation: Mineralized N = 29.0 + 0.20 precipitation for the 0- to 60-cm depth.

Effect of cropping, summerfallow, and fertilizer nitrogen on nitrate-nitrogen lost by leaching on a Brown Chernozemic loam. In 1982, six crop rotation treatments initiated in 1967 on an Orthic Brown Chernozemic loam were sampled for soil NO_3-N and moisture to a depth of 240 cm. Soil samples were taken on 18 May and 10 June from all treatments, on 2 September on fallow treatments only, and on 14 October from cropped treatments. Precipitation during the sampling period was about 23% above the long-term average. It was estimated that the amount of NO_3-N leached from the top 240 cm of fallow soils was at least 123 kg/ha. Leaching appeared to result from a portion of the precipitation moving through macro soil pores. There was evidence that water and NO_3-N might also move upward from below the 240-cm depth. Of the six rotations examined, the 2-yr and 3-yr spring wheat (*Triticum aestivum* L.) rotations lost the most NO_3-N. The presence of fall rye (*Secale cereale* L.) in a fallow–rye–wheat rotation was also very effective in reducing NO_3-N losses. Spring wheat when grown continuously was also effective in reducing NO_3-N losses, but even here there was some evidence of leaching beyond the root zone. Application of fertilizer N and P at amounts based on soil test recommendations reduced NO_3-N leached. It was estimated, from long-term precipitation data, that over the past 100 yr about 20% of the soil organic N that was present at the time of breaking the land has been lost from the soil via leaching. It was concluded that leaching losses of N from the soils on the Canadian prairies had been greatly underestimated and were partly responsible for losses attributed to the more visible wind erosion.

Bicarbonate-P distribution in soil and P uptake by the plant. The effect of crop rotation, N and P fertilizer and environmental factors on $NaHCO_3$-extractable-inorganic P (bicarbonate-P), and plant P were assessed. The soil had a high level of bicarbonate-P at the initiation of the experiment. Withholding P fertilizer for 12 yr did not reduce the level of bicarbonate-P, but frequent P application, using generally recommended rates of P, increased the bicarbonate-P in the top 15 cm of soil; the bicarbonate-P levels below 15-cm depth were unchanged. Bicarbonate-P changes during fallowing were significantly related to changes occurring in cropped treatments. There was no evidence of net P mineralization. Between spring and fall 66–88% of the variability in bicarbonate-P occurring in the top 15 cm of soil was related to soil moisture, air temperature, and their interaction. Invariably, bicarbonate-P increased between late fall and spring thaw. P uptake by plants was linearly related to time through to shot blade stage; the rate slowed thereafter, but uptake continued to maturity. The amount of P uptake was directly related to dry matter yield and positively influenced by N fertilizer. It was concluded that bicarbonate-P might not be the best indication of P availability and that a more detailed study of the cycling of P in these rotations would be invaluable.

Economics of crop rotations. Economic considerations of 12 crop rotations considered technically feasible for southwestern Saskatchewan were assessed. The results suggest that producers in this region should consider selecting a more intensive cropping system than has been traditional. The 3-yr fallow–wheat–wheat rotation with recommended rates of N and P fertilizers provided the highest expected net farm income (i.e., returns above all cash costs, depreciation, and labor) under most reasonable input cost and product price assumptions. Expected net farm income for the traditional 2-yr wheat rotation and for the continuous wheat rotation averaged 24% (or $20 to $22/ha) lower. Inclusion of flax, fall rye, or oat hay in the rotations lowered expected net farm income by 12 to 49% from comparable rotations that included only wheat. Application of recommended rates of N fertilizer increased expected net farm income for the 3-yr and continuous wheat rotations by 6.6% (or $6/ha) and 10.5% (or $7/ha), respectively. Use of fertilizer P in the 3-yr wheat rotation increased expected net farm income by an average of 20.6% (or $18/ha). Average production costs increased as the proportion of summerfallow in the rotation decreased. Fertilizer costs for the 3-yr and continuous wheat rotations averaged 68% and 266% greater, respectively, than for the 2-yr wheat rotations. Herbicide costs for the same rotations averaged 23% and 402% greater, whereas labor costs averaged 11% and 32% greater. Expenditures on fuel and oil were similar among the rotations because savings from reduced summerfallowing activities were offset by increased requirements for planting and harvesting. Break-even stubble-to-fallow yield ratios that provided equivalent net returns from stubble and fallow cropping averaged 64% for the 3-yr wheat rotation and 76% for the continuous wheat rotation. Annual income variability was greatest for the continuous crop rotations and lowest for the 2-yr wheat rotation.

Energy considerations of crop rotations. Energy inputs, energy output, and energy efficiency of 12 crop rotations considered technically feasible for southwestern Saskatchewan were summarized. Both direct and indirect energy input expenditures were considered. Energy output was measured as the metabolizable energy of the grain for human consumption. The results showed that total energy input per unit area was lowest for the traditional 2-yr fallow–wheat rotation (3132 MJ/ha), intermediate for the 3-yr fallow–wheat–wheat rotation (3765 MJ/ha), and highest for the continuous wheat rotation (6413 MJ/ha). Fuel use per unit area was similar among the rotations (1690 MJ/ha), but accounted for the greatest share of the total energy input of the 2-yr fallow–wheat rotation. Energy expenditures on fertilizers increased with the rotation length, accounting for 14–45% of the total energy requirements of the rotations. Energy output generally increased with the rotation length because of the greater quantity of annual grain production per unit area. Net energy produced (i.e., energy output minus energy input) was greatest for the continuous wheat rotation receiving recommended rates of N and P fertilizer (11 896 MJ/ha) and lowest for rotations that included flax. Relative to the 2-yr fallow–wheat rotation, the comparable 3-yr and continuous wheat rotations produced 20% and 32% more net energy per unit area, respectively. Energy output-to-input ratios for the various rotations ranged between 2.08 for the oat hay–wheat–wheat rotation and 4.24 for the fallow–wheat–wheat rotation that received only P fertilizer.

The effect of temperature, moisture, and nitrogen on the rate of development of spring wheat as measured by degree-days

A phenological index based on meteorological parameters that accurately describes the development of wheat is urgently needed by agricultural researchers. In this study, a biometeorological time scale was proposed. It was developed from data obtained in a growth chamber study in which the effects of temperature, N fertility, and soil moisture on spring wheat (*Triticum aestivum* L.) development were assessed. The model was then tested using data from two field experiments. A normalized time scale was derived relating phenological development to percentage of soft dough (% SD), defined as [(number of days to reach a selected phenological stage)/(number of days to reach soft dough)] × 100. The equation was used to derive values for the developmental parameters. In the growth room the rate constant, K, is 0.0875 % SD/°C per day (standard error 0.0045) and the base temperature below which no development occurs, b_0, is 4.6°C (standard error 0.99). Under field conditions $K^1 = 0.0935$ (standard error 0.0123) and $b_0 = 2.4$ (standard error 2.213). The growth room and field parameters were not significantly different at the 5% probability level. Temperature was the only environmental parameter that influenced the rate of development under the conditions of this experiment. The number of days to reach the various developmental stages was inversely and linearly related to mean daily temperature over the 15–25°C range. The degree-day equation was shown to be a good index of development. Under field conditions the number of degree-days to progress a crop to the flowering stage was 703 (standard error 9.4) and to the soft dough stage 1086 (standard error 15.4). The small variability in the values of the developmental parameters obtained in the growth room and field experiments were attributed to errors in the determination of phenological dates, and differences between temperature in the crop microclimate and measured temperatures from the standard meteorological site. A further modification to the degree-day equation was postulated to account for the influence of day length on wheat development.

PUBLICATIONS

Research

Bhargava, K. K.; O'Neil, J. B.; Prior, M. G.; Dunkelgod, K. E. 1983. Incidence of salmonella contamination in broiler chickens during rearing and processing. Can. J. Comp. Med. 43:301-309.

Campbell, C. A.; Davidson, H. R.; McCaig, T. N. 1983. Disposition of nitrogen and soluble sugars in Manitou spring wheat as influenced by N fertilizer, temperature and duration and stage of moisture stress. Can. J. Plant Sci. 63·73-90.

Campbell, C. A.; Read, D. W. L.; Zentner, R. P.; Leyshon, A. J.; Ferguson, W. S. 1983. First 12 years of a long-term crop rotation study in southwestern Saskatchewan—yields and quality of grain. Can. J. Plant Sci. 63:91-108.

Campbell, C. A.; Read, D. W. L.; Biederbeck, V. O.; Winkleman, G. E. 1983. First 12 years of a long-term crop rotation study in southwestern Saskatchewan—nitrate-N distribution of soil and N uptake by the plant. Can. J. Soil Sci. 63:563-578.

Clarke, J. M. 1983. Kernel moisture at physiological maturity and post-physiological maturity drying rate in wheat. Crop Sci. 23:1203-1205.

Clarke, J. M. 1983. Differential excised-leaf water retention capabilities of *Triticum* cultivars grown in field and controlled environments. Can. J. Plant Sci. 63:539-541.

Clarke, J. M. 1983. Relationship between field emergence of wheat and laboratory germination in D-mannitol. Cereal Res. Commun. 11:129-132.

Clarke, J. M.; De Pauw, R. M. 1983. The dynamics of shattering in maturing wheat. Euphytica 32:225-230.

Davidson, H. R.; Campbell, C. A. 1983. The effect of temperature, moisture and nitrogen on the rate of development of spring wheat as measured by degree days. Can. J. Plant Sci. 63:833-846.

de Jong, E.; Steppuhn, H. 1983. Water conservation: Canadian prairies. Pages 89-104 *in* Dregne, H. E.; Willis, W. O., eds. Dryland agriculture. Am. Soc. Agron. Crop Sci. Soc. Am., Soil Sci. Soc. Am., Agron. Monogr. Vol. 23.

de Jong, R.; Campbell, C. A.; Nicholaichuk, W. 1983. Water retention equations and their relationship to soil organic matter and particle size distribution in Saskatchewan soils. Can. J. Soil Sci. 63:291-302.

De Pauw, R. M.; McBean, D. S.; Townley-Smith, T. F.; Clarke, J. M.; McCaig, T. N.; Buzinski, S. R. 1982. Registration of Leader wheat. Crop Sci. 22:1265-1266.

De Pauw, R. M.; Townley-Smith, T. F.; McCrystal, G. E.; Lendrum, C. W. B. 1982. Registration of NB 320 red spring wheat germplasm. Crop Sci. 22:1278.

De Pauw, R. M.; McCaig, T. N. 1983. Recombining dormancy and white seed color in a spring wheat cross. Can. J. Plant Sci. 63:581-589.

Green, D. G.; Read, D. W. L. 1983. Water use efficiency of corn, sunflower and wheat with limiting soil moisture. Can. J. Plant Sci. 63:747-749.

Green, D. G. 1983. Soluble sugar changes occurring during hardening of spring wheat, fall rye and alfalfa. Can. J. Plant Sci. 63:415-420.

Jame, Y. W.; Nicholaichuk, W.; Leyshon, A. J.; Campbell, C. A. 1982. The boron concentration in soil solution under irrigation: A theoretical analysis. Can. J. Soil Sci. 62:461-471.

Larmond, E.; Salmon, R. E.; Klein, K. K. 1983. Effect of canola meal on the sensory quality of turkey meat. Poult. Sci. 62:397-400.

Looman, J. 1983. The vegetation of the Canadian Prairie Provinces. IV. The woody vegetation, Part 1. Phytocoenologia 11(3):297-330.

Looman, J. 1983. Water meal, *Wolffia arrhiza* (Lemnaceae) in Saskatchewan. Can. Field-Nat. 97(2):220-222.

McLeod, J. G.; McBean, D. S.; Buzinski, S. R. 1983. Registration of Musketeer winter rye. Crop Sci. 23:185.

McLeod, J. G.; McBean, D. S.; Buzinski, S. R. 1983. Registration of Frontier winter rye. Crop Sci. 23:185.

Nicholaichuk, W.; Grover, R. 1983. Loss of fall-applied 2,4-D in spring runoff from a small agricultural watershed. J. Environ. Qual. 23(3):412-414.

Oosterveld, M.; Nicholaichuk, W. 1983. Water requirements, availability and development restraints for crop productivity in Canada. Can. J. Plant Sci.63:33-34.

Salmon, R. E. 1983. Effect of duration of excreta collection on, and additivity of, true metabolisable energy values of feedstuffs. Nutr. Rep. Int. 27:655-660.

Salmon, R. E. 1983. The effect of the energy:protein ratio of the diet, strain and age at slaughter on performance and carcass quality of turkey broilers. Poult. Sci.62:824-831.

Salmon, R. E.; Classen, H.L.; McMillan, R.K. 1983. Effect of starter and finisher protein on performance, carcass grade and meat yield of broilers. Poult. Sci. 62:837-845.

Townley-Smith, T. F.; Hurd, E. A.; Patterson, L. A. 1983. Registration of Wascana durum wheat (Reg. No. 672). Crop Sci. 23:1014.

Townley-Smith, T. F.; Hurd, E. A.; Patterson, L. A. 1983. Registration of Wakooma durum wheat (Reg. No. 673). Crop Sci. 23:1015.

Townley-Smith, T. F.; Hurd, E. A.; Leisle, D.; Patterson, L. A. 1983. Registration of Macoun durum wheat (Reg. No. 674). Crop Sci. 23:1015.

Winkleman, G. E.; Leyshon, A. J. 1983. A low cost microcomputer data acquisition system for the Technicon autoanalyzer. Agron. J. 75:1047-1049.

Miscellaneous

Campbell, C. A. 1983. Erosion and soil fertility. Can. Agric. 4:25-26.

Campbell, C. A. 1983. Report on 2nd annual symposium of transfer processes in ecological systems—Bayreuth, West Germany. *In* Foreign visit report on science and technology. Agric. Can. Publ. IST83-1.

Campbell, C. A. 1983. Report on FAO/IAEA/GSF program on research on agricultural N residues. *In* Foreign visit report on science and technology. Agric. Can. Publ. IST83-2.

Campbell, D. W. 1983. Windpower application. Canadex 767.

Clarke, J. M. 1982. Wheat weathering damage in windrower-combine vs. direct-combine harvesting systems. Pages 281-293 *in* Kruger, J. E.; LaBerge, D. E., eds. Proceedings 3rd International Symposium on Preharvest Sprouting, Westview Press, Boulder, CO.

De Pauw, R. M.; McCaig, T. N. 1982. Recombining dormancy from RL 4137 with white seed color. Pages 251-259 *in* Proceedings 3rd International Symposium on Preharvest Sprouting Damage in Cereals, Hecla Island, Canada, Westview Press.

Jame, Y. W. 1983. Irrigating alfalfa with saline wastewater. Canadex 121-28.

Knipfel, J. E.; McCaig, T. N.; McLeod, J. G. 1983. Nutritional value of foods and feeds of plant origin: Relationship to composition and processing. Pages 361-379 *in* Waller, G. R.; Feather, M. S., eds. Maillard reactions in foods and nutrition. ACS Symposium Series 215(18).

Lawrence, T. 1983. Altai wild ryegrass. Agric. Can. Contrib. 1983-3E.

Lawrence, T. 1983. Intermediate wheatgrass. Agric. Can. Contrib. 1983-2E.

McCaig, T. N.; De Pauw, R. M. 1982. Falling number and alpha-amylase in sawfly resistant wheats. Pages 79-88 *in* Proceedings 3rd International Symposium on Preharvest Sprouting Damage in Cereals, Hecla Island, Canada, Westview Press.

Research Station
Beaverlodge, Alberta

PROFESSIONAL STAFF

L. P. S. Spangelo, B.S.A., M.Sc., Ph.D.	Director
W. H. Marshall	Administrative Officer

Cereal and Oilseed Crops

R. I. Wolfe, B.S.A., B.D., Ph.D.	Head of Section; Cereal breeding
R. S. Sadasivaiah, B.Sc., M.Sc., Ph.D.	Rapeseed

Environment and Soils

W. A. Rice, B.S.A., M.Sc., Ph.D.	Head of Section; Microbiology
A. L. Darwent, B.S.A., M.Sc., Ph.D.	Weed control
J. G. N. Davidson, B.S.F., M.Sc., Ph.D.	Plant pathology
J. S. McKenzie, B.S.A., M.Sc., Ph.D.	Plant survival
P. F. Mills, B.A.	Micrometeorology
Y. K. Soon, B.S.A., M.Sc., Ph.D.	Soil chemistry
Vacant	Soil physics

Forage Crops and Apiculture

S. G. Bonin, B.S.A., Ph.D.	Head of Section; Grass breeding
D. T. Fairey, B.Sc., M.Sc., Ph.D.	Legume seed physiology
N. A. Fairey, B.Sc., M.Sc., Ph.D.	Forage production
Vacant	Grass seed management
D. L. Nelson, B.S.A., M.Sc.	Head of Unit; Apiculture
T. P. Liu, B.Sc., M.Sc., Ph.D.	Apiculture pathology
T. I. Szabo, B.A.E., M.Sc., Ph.D.	Apiculture

Experimental Farm, Fort Vermilion, Alta.

B. Siemens, B.S.A., M.Sc.	Superintendent; Forage crops
G. W. Clayton, B.S.A., M.Sc.	Crop production specialist

Departure

A. M. F. Hennig, B.Sc. Retired September 1983	Crop management

VISITING SCIENTISTS

Agricultural Research Council of Alberta

J. V. Christensen, B.Sc.	Cereal agronomy
H. G. Najda, B.S.A., M.P.M.	Forage agronomy

INTRODUCTION

The Northern Research Group, comprising the Research Station at Beaverlodge and the associated Experimental Farm at Fort Vermilion, Alta., continued its responsibility for research on agricultural problems of northwestern Canada. This report presents highlights of research for 1983.

A major accomplishment includes the development of two new strains of honey bees to be released in 1984. Under optimum colony management conditions, these new strains have the potential of increasing average colony honey yield by more than 40%.

It is encouraging that the Station's winter survival stress test has continued to be a highly satisfactory method of identifying hardy alfalfa strains.

Initiation of the urgently required research on soil chemistry and fertility in the North was made possible by the addition of one research scientist.

Detailed information can be obtained from the publications listed in this report. Correspondence to individual research scientists should be addressed to the Research Station, Research Branch, Agriculture Canada, Box 29, Beaverlodge, Alta. T0H 0C0; and the Experimental Farm, Research Branch, Agriculture Canada, Fort Vermilion, Alta. T0H 1N0.

L. P. S. Spangelo
Director

APICULTURE

Breeding

Requeening honey bee colonies. A study was conducted to determine the fate of introduced and unprotected queen cells in producing colonies, and whether a newly emerged queen could be successful in replacing an old queen. Seventy percent of the mature queen cells emerged when placed in queen right colonies during the nectar flow, 11% of the cells were destroyed, 6% contained dead queens, and 13% were not found. Thirteen percent of the colonies were successfully requeened by this method. Fifty-three percent of the resident queens were retained and 24% were replaced by new queens reared in the colony. More queens emerged from the introduced cells and fewer cells were destroyed in overwintered colonies than in package colonies, but there was no difference between colony types in the number of old queens replaced by new ones.

Management

The effect of comb types on colonies. The effect of previously used brood combs, foundation, and starter strips was investigated to evaluate comb building, brood rearing, and seasonal weight gain by colonies. In each summer from 1976 to 1979, five colonies in each of the following seven groups were observed: two groups of overwintered colonies were supplied with dark combs. Their average weight gain was 78 kg per colony. In five groups of package colonies, two were provided with dark combs, one with white combs, one with foundation, and one with starter strips. The average weight gain for these colonies was 82 kg in colonies provided with dark combs, 79 kg with white combs, 64 kg with foundation, and 43 kg with starter strips. Package groups given starter strips had significantly less capped worker brood area than those given dark combs or foundation.

Wintering

Hive direction and entrance location. The effects of entrance location and hive direction on wintered honey bee colonies were investigated during the 1979–1980 and 1980–1981 winters. Treatments included: (*1*) bottom and top entrances (1 × 5 cm each), (*2*) fully open bottom entrance, (*3*) bottom and upper-side entrances (1 × 5 cm each), (*4*) bottom entrance (1 × 5 cm), and a 2.5-cm diameter auger hole in the middle of the second chamber. The colonies in two supers were placed in groups of four and packed with R7 fiber glass insulation and building paper. Each group, representing one treatment, had two colonies facing north and two colonies facing south.

Colonies in treatments *1* and *4* consumed less food than colonies in treatment *3*. Spring populations for treatments *1* and *4* were identical (8.5 combs of bees per colony) and significantly greater than those of treatments *2* and *3* (7.0 and 5.0 combs of bees per colony, respectively). The capped worker brood area was 3044 cm², 3031 cm², and 1976 cm² in treatments *1*, *4*, and *3*, respectively. The populations in south-facing colonies were significantly greater than the populations in north-facing colonies.

Nosema. A scanning electron microscopic technique was developed for taxonomic identification of spores of *Nosema apis* from the infected midgut of honey bees. The fractured face of the Epon-embedded specimen showed that the spore surface is smooth, whereas specimens of isolated spores and spores in the infected tissue showed that the spores possessed a rough surface.

Contract research

Application of aversion techniques for the reduction of losses to beehives by black bears. The aversion compound thiabenoazole NF incorporated into a bait of slum gum and beeswax, placed in 1-L milk cartons, and hung around bee yards (10 per yard at 1.5 m from the ground) was an effective means of reducing black bear damage. Baits are usually consumed until the bear becomes ill. This association with the bee yard causes an aversion reaction. Twelve percent of the test yards and 46% of the control yards received damage. The multiple-bait system enables sufficient chemical to be placed at the bee yard to adequately dose bears of unknown size.

CEREAL AND OILSEED CROPS

Barley breeding. Significant progress has been made in the incorporation of scald (*Rhynchosporium secalis*) resistance into barley lines. Resistance was obtained from locally adapted cultivars and introduced germ plasm. Scald inoculum was increased from naturally occurring lesions collected off early sown crops in the region, and sprayed onto test plots.

ENVIRONMENT AND SOILS

Nitrogen fixation

Antigenic characterization of Rhizobium strains. Accurate and convenient identification of strains of *Rhizobium meliloti* is required for screening for isolates with improved N_2 fixation potential and for studies of inter-strain relationships. The somatic antigens of eight *R. meliloti* strains were characterized by the indirect enzyme-linked immunosorbent assay (ELISA) technique carried out in microtiter plates. Four of the strains were found to possess distinctive antigens and a total of seven different combinations of antigens was found among the eight strains. Only one pair of the strains was not distinguishable by the assay used. Somatic antigen variability among strains of *R. meliloti* is high, and provides the means for accurate strain identification. The antigenic characterization can be conveniently accomplished with the indirect ELISA technique.

Competitive ability of two R. meliloti strains. The production, packaging, and marketing of alfalfa inoculant for Canada could be simplified if *Rhizobium meliloti* strains selected on a regional basis could be combined into one inoculant. The ELISA technique was used to determine the competitive ability of *R. meliloti* Balsac, selected for Eastern Canada, and *R. meliloti* NRG-185, selected for Western Canada. Total plant weight was highest for the single strain inocula, and was decreased 5–19% with dual strain inocula. The decrease in total plant weight was significantly correlated with decreases in nodule number and nodule weight. The results suggest that *R. meliloti* strains Balsac and NRG-185 have equal competitive ability but are antagonistic, resulting in decreased nodulation and N_2 fixation when both are present in an inoculum.

Plant survival

Winter-hardy alfalfa. Stress tests to induce winterkill in the field have been used to identify winter-hardy alfalfa strains. A strain obtained from Irkietsk Province, USSR, and germ plasm collections from Fort Resolution and Fort Smith, N.W.T., have superior winterhardiness to standard alfalfa cultivars used in Western Canada.

FORAGE CROPS

Seed production

Chalkbrood survey. Alfalfa seed producers in Western Canada have been concerned about the possibility of chalkbrood, *Ascosphaera aggregata*, occurring in alfalfa leafcutting bee cocoons. Alfalfa leafcutting bees are the predominant pollinators of alfalfa and the incidence of this disease would adversely affect both the seed and bee industries. In response to producers' requests, a survey to screen for the incidence of chalkbrood in alfalfa leafcutting bee cocoons was initiated in cooperation with the Biosystematics Research Institute, Ottawa. In the 1982–1983 survey, chalkbrood was not found in any of the samples that were submitted from the four western provinces.

Weed control

Control of broad-leaved weeds in seed producing fields of creeping red fescue. Bromoxynil plus MCPA applied at 0.28 + 0.28 kg/ha when creeping red fescue (*Festuca rubra* var. *geniura* L.) was in the three-leaf stage (and 1–2 mo old) controlled 75%, or more, of the annual weeds during the year of seeding and also provided substantial control of dandelions and other weeds when applied during the year following seeding. A second herbicide treatment of dicamba plus 2,4-D with active ingredients (a.i.) of 0.28 + 0.56 kg/ha in May of the year following seeding, provided an improvement in the control of dandelions and other weeds over the single application of bromoxynil plus MCPA. The use of rapeseed as a companion crop without any herbicide treatments did not provide consistent weed control. Seed yields during the second production year were increased by 25%, or more, by using these two herbicide treatments when the fescue was seeded alone or with barley harvested for fodder. Seed yields during the first production year were not increased by any of the herbicide treatments. Similarly, first and second production year seed yields were not increased by any of the herbicide treatments when the fescue was seeded with barley harvested for grain. Harvesting barley as fodder rather than as grain produced marginally higher first production year fescue seed yields but had no effect on second production year seed yields.

PUBLICATIONS

Research

Clarke, J. M.; Reimer, G. E.; Christensen, J. V.; Legge, W. G. 1982. Effect of kernel moisture content at harvest and windrow vs. artificial drying on quality and grade of oats. Can. J. Plant Sci. 62:845-854.

Fairey, N. A. 1982. Yield, quality and development of forage maize as influenced by date of planting and harvesting. Can. J. Plant Sci. 63:157-168.

Fisher, L. J.; Fairey, N. A. 1982. The effect of planting density on the nutritive value of corn silage for lactating cows. Can. J. Anim. Sci. 62:1143-1148.

Liu, T. P. 1982. A scanning electron microscope study on the female mite *Varroa jacobsoni* (Oudemans, 1904). Am. Bee J. 122:413-415.

Liu, T. P. 1983. Surface structure of spores of *Nosema apis* Zander as seen in the scanning electron microscope. Am. Bee J., Apicult. Res. 123:810-811.

Major, D. J.; Bootsma, A.; Brown, D. M.; Dupuis, G.; Fairey, N. A.; Grant, E. A.; Green, D. G.; Hamilton, R. I.; Langille, J.; Sonmor, L. G.; Smeltzer, G. C.; White, R. P. 1982. An evaluation of the corn heat unit system for the short season growing region across Canada. Can. J. Plant Sci. 63:121-130.

Olsen, P. E.; Wice, W. A.; Stemke, G. W.; Page, W. J. 1982. Strain specific serological techniques for the identification of *Rhizobium meliloti* in commercial alfalfa inoculants. Can. J. Microbiol. 29:225-230.

Piening, L. J.; Duczek, L. J.; Atkinson, T. G.; Davidson, J. G. N. 1983. Control of common root rot and loose smut and the phytotoxicity of seed treatment fungicides on Gateway barley. Can. J. Plant Pathol. 5:49-53.

Rice, W. A.; Olsen, P. E. 1983. Inoculation of alfalfa seed for increased yield on moderately acid soil. Can. J. Soil Sci. 63:541-545.

Szabo, T. I. 1982. Requeening honeybee colonies with queen cells. J. Apicult. Res. 21:208-211.

Szabo, T. I. 1983. Effects of various entrances and hive direction on outdoor wintering of honey bee colonies. Am. Bee J., Apicult. Res. 123:47-49.

Szabo, T. I. 1983. The Alberta nucleus hive. Am. Bee J., Apicult. Res. 123:207-209.

Szabo, T. I. 1983. Effect of various combs on the development and weight gain of honeybee colonies. J. Apicult. Res. 22:45-48.

Miscellaneous

Darwent, A. L.; Smith, J. H. 1983. Weed control in grass seed crops. 1. Broadleaved weed control in seedling stands. North. Res. Group Publ. 83-8.

Darwent, A. L.; Smith, J. H. 1983. Weed control in grass seed crops. 2. Tolerance of seedling grasses to herbicides for wild oat control. North. Res. Group Publ. 83-9.

Darwent, A. L.; Smith, J. H. 1983. Weed control in grass seed crops. 3. Creeping red fescue tolerance to 2,4-D and Banvel. North. Res. Group Publ. 83-10.

Darwent, A. L.; Smith, J. H. 1983. Weed control in grass seed crops. 4. Tolerance of established timothy to herbicides for broadleaved weed control. North. Res. Group Publ. 83-11.

Darwent, A. L. Smith, J. H. 1983. Weed control in grass seed crops. 5. Dandelion control in creeping red fescue and other grasses. North. Res. Group Publ. 83-12.

Fairey, N. A. 1983. Alberta crop evaluation program for forage crops. North. Res. Group Publ. 83-30. 13 pp.

Fairey, N. A.; Pringle, W. L. 1983. Pure stands versus alternate rows of grasses and legumes in the Peace River region of Alberta. Canadex 120.10.

Fairey, N. A.; Pringle, W. L. 1983. Sainfoin: Row spacing and mixtures for forage in the Peace River region of Alberta. Canadex 120.10.

Fairey, N. A.; Pringle, W. L. 1983. Forage productivity of some annual crops in the Peace River region of Alberta. Canadex 120.10.

Fairey, N. A.; Pringle, W. L. 1983. Row spacings for perennial forages in the Peace River region of Alberta. Canadex 120.22.

Fairey, N. A.; Pringle, W. L. 1983. Responses of perennial forages to irrigation in the Peace River region of Alberta. Canadex 120.135.

Fairey, N. A.; Pringle, W. L. 1983. Seeding dates for perennial grasses in the Peace River region of Alberta. Canadex 127.22.

Fairey, D. T.; Lieverse, J. A. C. 1983. *Pteromalus venustrus*: A parasite of leafcutting bees. North. Res. Group Publ. 83-14.

Fairey, D. T.; Nelson, D. L.; Lieverse, J. A. C. 1983. Chalkbrood incidence in leafcutting bees. Report on 1982-83 survey. North. Res. Group Publ. 83-15.

Fairey, D. T. 1983. The leafcutting bee in the Peace River region. North. Res. Group Publ. 83-17.

Fairey, D. T. 1983. Red clover. North. Res. Group Publ. 83-22.

McKenzie, J. S.; Rice, W. A.; Hennig, A. M. F.; Siemens, B.; Pringle, W. L. 1983. A summary of alfalfa variety and fall cutting management studies at seven locations in the Peace River region of Alberta from 1975 to 1980. North. Res. Group Publ. 83-2. 61 pp.

McKenzie, J. S. 1983. Alfalfa varieties and cutting management recommendations to reduce the effect of winterkill in the Peace River region. North. Res. Group Publ. 83-23.

Mills, P. F.; Hodges, R. 1983. Weather observations for 1982 with summaries and averages for 67 years of continuous recording. North. Res. Group Publ. 83-3.

Mills, P. F. 1983. The 1983 crop weather conditions in the Peace River region. North. Res. Group Publ. 83-20.

Najda, H. G. 1983. Forage cultivar trials. North. Res. Group Publ. 83-16B. 36 pp.

Nelson, D. L. 1982. The effect of queen-related problems and swarming on brood and honey production. Am. Bee J. 122:636-637.

Nelson, D. L. 1983. Honey bees and thermoregulation—A review. North. Res. Group Publ. 83-31.

Nelson, D. L.; Jay, S. C. 1982. Honey production with packaged bees in Western Canada. Bee World 63:110-117.

Wolfe, R. I.; Sadasivaiah, R. S.; Davidson, J. G. N.; Mills, P. F.; Clarke, P. J.; Johnson, D. K.; Fletcher, C. F.; Karl, P. E. 1983. Tests on cereal and oilseed crops in the Peace River region—1982. North. Res. Group Publ. 83-5.

Wolfe, R. I. 1983. An outline of barley and oat breeding methods for Agriculture Canada, Research Station, Beaverlodge. North. Res. Group Publ. 83-40.

Research Station
Lacombe, Alberta

PROFESSIONAL STAFF

D. E. Waldern, B.S.A., M.S.A., Ph.D.	Director

Animal Science

J. A. Newman, B.Sc., Dip.An.Gen., Ph.D.	Head of Section; Beef cattle breeding
H. T. Fredeen, B.S.A., M.Sc., Ph.D., F.A.I.C.	Animal breeding
A. P. Sather, B.Sc., M.S., Ph.D.	Swine breeding and management
A. K. W. Tong, B.Sc., M.Sc., Ph.D.	Beef cattle breeding and management (ROP)

Meats

A. H. Martin, B.S.A., M.S.A.	Head of Section; Meat science
H. Doornenbal, B.S.A., M.S.A., Ph.D.	Physiology
G. G. Greer, B.Sc., M.Sc., Ph.D.	Microbiology
L. E. Jeremiah, B.S., M.S., Ph.D.	Food technology
A. C. Murray, B.Sc., Ph.D.	Biochemistry

Cereal Breeding, Pathology, and Forage

M. L. Kaufmann, C.D., B.S.A., M.Sc., Ph.D.	Head of Section; Barley breeding
V. S. Baron, B.Sc., M.Sc., Ph.D.	Forage physiology
W. B. Berkenkamp, B.Sc.. M.S., Ph.D.	Forage crops, forage pathology
L. J. Piening, B.Sc., M.Sc., Ph.D.	Cereal pathology

Crop Management and Soils

P. A. O'Sullivan, B.Sc., Ph.D.	Head of Section; Weed physiology
S. S. Malhi, B.Sc., M.Sc., Ph.D.	Soil chemistry

Statistics and Data Processing

G. M. Weiss, B.S.A., M.Sc.	Head of Section; Data processing
L. R. Fobert	Systems and programming
D. Lamkin	Computer programming

Soils and Crops Substation, Vegreville

J. R. Pearen, B.Sc., B.Ed., M.Sc.	Acting Officer in Charge; Crop

Departures

C. D. Caldwell, B.Sc., M.Sc., Ph.D. October 1983	Crops physiology
M. R. Carter, B.Sc., M.Sc., Ph.D. February 1983	Officer in Charge; Soil fertility and management
T. J. Jones July 1983	Administrative Officer

INTRODUCTION

The Lacombe Research Station and the Soils and Crops Substation at Vegreville are responsible for regional agricultural research in the central Alberta parklands. Specifically, programs include: soil reclamation and development of cropping practices for Solonetzic soils of east-central Alberta; breeding new, high-yielding, disease-resistant feed barley and oat varieties for domestic use and export; and developing soil fertility, soil management, weed control, and cropping systems for barley, oat, and rapeseed production in the parklands. The Station has regional responsibility for production and disease research of annual forage crops, specifically screening and selecting species and varieties that will be used by beef and dairy farmers for silage and pasture to give optimum yield per hectare of digestible energy. The Lacombe program also includes research responsibility for regional and national programs in swine and beef cattle breeding; the technical research aspects of record of performance (ROP) beef cattle and swine testing programs; and major carcass evaluation research related to national departmental beef and swine carcass grading programs. The meats research includes work on the physical, chemical, microbiological, and sensory aspects of beef and pork quality in relation to pre- and post-slaughter conditions and carcass management, both at the meat-packing plant and at the retailer level, and with consideration given to cooking quality and other factors related to consumer acceptance of the final product.

This report summarizes the highlights of research completed in 1983. Further information on any of these research activities, reprints of publications listed in this report, and copies of previous reports may be obtained from the Research Station, Research Branch, Agriculture Canada, Box 1420, Lacombe, Alta. T0C 1S0.

D. E. Waldern
Director

ANIMAL BREEDING

Beef cattle

The effects of group size on growth rate in groups of steer calves fed through single stall feeding devices. In recent years electronic devices based on a single feeding stall have been promoted for recording individual feed consumption in groups of calves during a post-weaning performance test. Manufacturers have claimed that the single feeding stall can accommodate a group of up to 15 calves, and evidence confirming this claim has been provided by research recently completed at the Lacombe Research Station. Over a period of 2 yr a total of 200 Shorthorn and exotic crossbred steer calves were fed in groups of 10 or 15 head, using four feeding stalls of each of two different types of equipment.

These were the "Pinpointer" unit manufactured by Universal Identification Systems Inc., Cookeville, TN, and the "Sensifeed" unit manufactured by Senstek Ltd., Saskatoon, Sask. Data for one anomalous pen × (28-day) feeding period subclass were excluded. For the remaining 63 subclasses, mean individual 28-day gains of steers ranged from 30.0 ± 1.8 to 59.0 ± 1.8 kg for groups of 10 and from 31.2 ± 1.4 to 57 ± 1.6 kg for groups of 15 head. Differences in mean individual 28-day gain (groups of 10 minus groups of 15) during the same feeding period ranged from −2.1 ± 2.8 kg to +3.5 ± 2.2 kg. None of these differences approached statistical significance.

This research has demonstrated that differences in individual feed access between groups of 10 head and groups of 15 head per feeding stall did not affect the growth rate of calves on an all concentrate diet. It also suggests that single stall self-feeding devices can accommodate up to 15 head of steer calves without impairment of feed access or growth rate.

Swine

Ultrasonic probing technique for Canadian swine ROP. During recent years it has become apparent that there are regional differences in the interpretation of back fat probing site definitions by the swine ROP technicians across Canada. Although the resulting errors in fat depth measurements may not affect ranking or selection decisions amongst pigs probed by a single technician, they do tend to invalidate differences amongst herds and regions in which probing was done by different technicians. A comprehensive research project has been conducted in cooperation with the Alberta Pork Industry Branch to assess the magnitude of this problem and to provide better definitions of probe sites.

Pigs were probed at 80, 90, 100, and 110 kg live weight, using two sets of probe site definitions. Sites on the back were defined as being aligned with the root (B1) or the apex of the curve (B2) of the last rib. Loin sites were defined as 15 cm posterior to B1 (L1) or directly above the stifle joint of the hind leg when the pig is standing normally (L2). All measurements were made 5 cm lateral to the midline.

Differences between fat depth probes at the B1 and B2 sites ranged from 0.2 mm on 80-kg pigs to 0.4 mm on 110-kg pigs. These differences are small enough to suggest that fat depth in the mid-back region is relatively uniform and that valid comparison amongst animals is not critically dependent on precise definition of this probing site. However, differences between the L1 and L2 sites were much larger, ranging from 1.63 mm on 80-kg pigs to 2.74 mm on 100-kg pigs. Precise location of the loin probing site is, therefore, critical to valid comparisons amongst pigs.

When used in equations to predict the percentage of dissectible fat in the carcass, the two sets of probe sites did not differ appreciably. Either accounted for 65 to 75% of the variance in fat content of pigs slaughtered in the normal weight range (90–100 kg).

The results of this study have revealed that imprecise definition of the loin probing site will invalidate comparisons amongst pigs, herds, and regions in the Canadian swine ROP program. This, in turn, has revealed a need for a precise, practical definition of the loin probing site and consistent training and monitoring of swine probing technicians across Canada. To meet these needs, the probing sites have been more precisely defined (*1*) as a point immediately above the curve of the last rib and 5 cm lateral to the midline, and (*2*) a point 2.5 cm anterior to the horns of the pelvic girdle and 5 cm lateral to the midline. These results are being communicated in probing technician training courses across Canada.

MEATS

Slaughter technology

Muscle fiber orientation and beef tenderness. Meat cores for the estimation of tenderness by Warner-Bratzler shear force measurement are usually obtained from cooked steaks in one of two methods—by coring parallel to the longitudinal axis of the muscle fibers or by coring perpendicular to the surface of the steak. A recent research report indicated that for the longissimus dorsi (LD) muscle both approaches result in identical shear force values, suggesting that control of muscle fiber orientation during shearing may not be very critical. The present study was initiated to ascertain for the LD muscle the extent to which the orientation of muscle fibers at the time of shearing or biting influences (*1*) objective and subjective measurements of tenderness, and (*2*) the relationship between these tenderness measurements.

The muscle fiber orientation within a particular cooked beef steak was found to vary considerably and to be markedly affected by vacuum packaging, freezing and/or cooking. Shear force values, initial-bite tenderness (panel), and cooking loss were highly dependent on muscle fiber orientation, but overall tenderness (panel) was only slightly dependent on it. These measures were affected to a greater extent in tough meat than in tender meat. At each of three fixed muscle fiber orientations, correlations within tenderness measures were significant. However, on a within-animal basis, cooking loss was related to shear value and to initial-bite tenderness apparently through an effect of fiber orientation. This effect may constitute a major source of variation in the measurement of tenderness and cooking loss. Shear force values, although dramatically affected by fiber angle, were adequate estimators of the overall panel tenderness of the LD muscle if the muscle fiber orientation was controlled.

Microbiology

Bacteriophages active on beef spoilage bacteria. About 80% of the psychrotrophic microflora of spoiled retail beef was identified as *Pseudomonas* strains, whereas the remaining 20% was characterized as *Brocothrix thermosphacta.* These bacteria were used as hosts for the isolation of bacteriophages (phages) from spoiled rib steaks under psychrotrophic conditions (7°C). A total of 38 psychrotrophic phages, actively lytic on 37 pseudomonads was isolated and purified from spoiled rib steaks. An additional 21 phages, lysing 16 *B. thermosphacta* strains were also isolated. The true psychrotrophy of these phages was demonstrated by increased plaque size and plating efficiency as incubation temperature was reduced from 25 to 1°C. Furthermore, phages were found to inhibit the growth of spoilage bacteria in liquid culture by significantly extending the lag phase of growth.

Strain differences within *Pseudomonas* and *B. thermosphacata* species could be established on the basis of differential susceptibility to phage lysis. Using this criterion, phage typing sets were derived which should provide a rapid and sensitive method of identifying strains of beef spoilage bacteria. In this fashion, phage typing would be a useful adjunct to classical cultural and biochemical tests in the characterization of psychrotrophic spoilage bacteria. Phage typing may also be of value in determining the source of bacterial contamination, in tracing the fate of specific bacterial strains during food processing, and in examining strain distribution during the spoilage of meats and other refrigerated foods.

Physiology

Effects of age, breed, sex, and muscle on certain mineral concentrations in cattle. The evaluation of mineral concentrations in animal tissues is of major importance with respect to both safety and adequacy for human nutrition, particularly as minerals are more readily available to man in the form of animal products. Concentrations of K, Na, Fe, Zn, Ca, Cu, and Mg were determined in the longissimus dorsi, semimembranosus, and diaphragm muscles. In 94 market weight animals the average concentrations of the elements in parts per million of wet weight in the three muscles ranged as follows: Cu, 0.70–1.66; Fe, 18.0–38.1; Ca, 23.8–30.2; Zn, 26.8–40.5; Mg, 198–248; Na, 528–708; and K, 3060–3840. The concentrations of all seven elements in the diaphragm muscle were significantly different from those in the other two muscles. The Cu, Fe, Zn, and Mg contents in the longissimus dorsi were significantly different from those in the semimembranosi. Sex and breed differences were less pronounced. In a group of 20 mature cows, Fe, Ca, Zn, Mg, and Na levels in the tissue studied were affected by age.

Meat quality

Palatability attributes of pork. Previous research at the Lacombe Research Station and elsewhere has shown that for economic production of swine, optimum market weights for both barrows and gilts ranged from 100 to 110 kg. Such market weights are significantly heavier than the 90 kg at which Canadian hogs have traditionally been marketed. However, for a move to marketing heavier hogs to be successful assurance must be obtained that feeding hogs to heavier weights would not significantly alter the palatability of the product in a negative way.

Research was undertaken to evaluate the eating quality of pork slaughtered at different weights from less than 79.5 kg to more than 134 kg. Both cooking properties and palatability attributes of loin chops from 130 barrows and 113 gilts were evaluated in this study. Results indicated that the slaughter weight of both barrows and gilts could be increased to take advantage of potential economic advantages, without meaningfully altering cooking losses or palatability attributes.

CEREAL BREEDING, PATHOLOGY, AND FORAGES

Forage crops

Effect of seed treatments on emergence of alfalfa. Alfalfa seed (cultivar Beaver) was treated with five fungicides and tested for emergence at 21 location-years in central Alberta during the period 1981–1983. Fungicides significantly increased alfalfa emergence over the control in 8 of 21 tests, although failing to show a significant effect in 10 of the 21 tests.

The five fungicide treatments varied in consistency and degree of effect on seedling emergence. Metalaxyl increased emergence significantly in six location-years, and captan in one location-year. Baytan and benomyl significantly decreased emergence in one test each; thiram increased and decreased emergence in two different location-years. The average emergence of the untreated alfalfa seed in all location-years was 41.9%. Seed treated with metalxyl emerged at 117.8% of the untreated check, captan emerged at

108.9%, thiram at 101.0%, baytan at 93.7%, and benomyl at 88.9%.

Cereal pathology

Control of root rot in barley. Through adjustment of cultural practices it is possible to reduce but not completely control root rot in barley on the Canadian prairies. Rotation studies suggest that bromegrass before barley reduced root rot on the number of plants infected from 90% to under 5%. This was correlated with a similar reduction in the number of spores of one of the causal agents, *Cochliobolus sativus*, found in the soil after grass. Canola and oats also reduced root rot in the succeeding barley crop from 90% to 50%. However, the incidence of root rot was unaffected by a previous barley crop or by summerfallow.

Increased plant spacing reduced root rot in Bonanza and Gateway barley in only 1 out of 4 yr, suggesting this is unreliable as a method of root rot control. However, increasing cultivation depth from 5 to 25 cm prior to seeding markedly reduced root rot of five barley cultivars.

Under greenhouse conditions (15°C and 20°C) root rot on four barley cultivars caused by *Fusarium* and/or *C. sativus* was significantly increased when soils were wetter or dryer than optimum moisture-holding capacity.

CROP MANAGEMENT AND SOILS

Weed research

Chlorsulfuron reduced control of wild oats with diclofop, difenzoquat, and flamprop. The influence of chlorsulfuron on control of wild oats when mixed in the spray tank with three herbicides was tested in greenhouse and in field trials at Lacombe and Scott, Sask., during 1981 and 1982. In field experiments chlorsulfuron mixed with diclofop caused a 4–35% reduction in control of wild oats. Mixtures of chlorsulfuron with difenzoquat caused a 0–19% reduction and mixtures with flamprop caused a 2–30% reduction in control of wild oats. Addition of chlorsulfuron to the wild oat herbicides under greenhouse conditions also resulted in losses in control of wild oats. Increasing the rate of the wild oat herbicide in the mixture tended to overcome these losses.

Control of Canada thistle and tolerance of barley and wheat to 3,6-dichloropicolinic acid. Control of topgrowth of 10-cm tall Canada thistle was excellent, and barley yields were increased when 3,6-dichloropicolinic acid was applied at rates of 0.2 kg/ha, and higher. No injury to barley (cultivars Galt and Klondike) was evident with herbicide rates of 0.1–0.9 kg/ha applied at the three-leaf, six-leaf, and boot stages and yields were not adversely affected. Glenlea wheat was tolerant to field applications of 3,6-dichloropicolinic acid at 0.1–0.9 kg/ha at the three- and six-leaf stage and boot stage. Neepawa yield was reduced with 0.9 kg/ha at the three- and six-leaf stage and with 0.6 kg/ha at the boot stage. Both cultivars are sufficiently tolerant to permit use of 3,6-dichloropicolinic acid for control of Canada thistle at 0.2–0.3 kg/ha.

Estimating yield loss of rapeseed due to Canada thistle. Data were collected from nine farm fields over 2-yr to determine the relationship between percentage of yield loss of rapeseed and density of Canada thistle. Correlation coefficients between percentage of rapeseed yield loss and numbers of Canada thistle shoots per metre, using both representations of the data, yielded the following equations: $\hat{Y} - 3.83 + 1.48x$ and $\hat{Y} - 18.63 + 10.42 \sqrt{x}$, where $\hat{Y}$ equals the estimated percentage of yield loss of rapeseed, and x equals the number of Canada thistle shoots per square metre; 1.48 and 10.42 are the indices of competition for the first and second equation, respectively. The first equation probably provides a more accurate estimate of percentage of yield loss at low (less than five shoots per square metre) and high (more than 40 shoots per square metre) levels of thistle infestations. Both equations provide equally acceptable estimates of yield loss at intermediate levels of infestation (5–40 shoots per square metre).

Soil fertility

Fate of fall-applied nitrogen fertilizers. Fall application of nitrogen (N) fertilizers is often less effective than spring application in increasing yields of cereal crops in the Prairie Provinces of Canada. Five field experiments were conducted using ^{15}N-labeled fertilizers to determine the amounts of mineral N lost over the winter by denitrification, leaching, and immobilization.

Soil samples were taken from 82 stubble fields over 8 yr in central Alberta during fall and spring. On average, the soils increased in nitrate N by 20 kg/ha between fall and spring. Of the total 82 tests, 19 tests showed an increase in nitrate N from fall to spring ranging from 21 to 30 kg/ha. In 14 tests the increase ranged from 31 to 51 kg/ha. This indicates that fall sampling can result in serious errors in nitrogen fertilizer recommendations. In some soils the recommendations for fertilizer N will be too high, resulting in a higher cost of fertilizer input.

In 26 field tests the soils were sampled twice (early fall and late fall) to find if late fall sampling can minimize errors in N fertilizer recommendations caused by soil sampling time. The nitrate N analyses of these samples indicated that farmers would overfertilize by about 20 kg/ha if they sample in early fall compared to late fall. This demonstrates that errors in fertilizer N recommendations caused by soil sampling time can be reduced simply by delaying soil sampling to the end of October or early November when soil temperatures are near freezing.

SOILS AND CROPS SUBSTATION VEGREVILLE

Soil research

Spatial variability of Solonetzic soils in north-central Alberta. For Solonetzic soils which occupy approximately 4 million hectares of land in Alberta, sampling presents particular difficulties due to the extreme variability observed in soil properties over short distances. A study was initiated in 1979 to examine the variability of several soil properties of ameliorative and agronomic significance for Solonetzic soils from 78 farm locations over 2 yr in north-central Alberta. In addition, intensive sampling on a 5-m grid for a small area (0.15 ha) of Solodized Solonetz-Solonetzic soil intergrade was performed on-station to determine if the variability of these properties displayed any spatial dependence.

The electroconductivity (EC), an index of soil salinity, was extremely variable in both the Ap and Bnt horizons. By way of contrast, the variability of soil pH was low in all three horizons. The variability of extractable cations examined (sodium, magnesium, and calcium) was relatively intermediate for all horizons examined. Of particular agronomic interest is the relative levels of calcium salts encountered within the plowshare depth of the Csk horizon. Approximately 30% of the sampled top 15 cm of Csk contained no gypsum. When present, the gypsum level ranged from approximately 0.3 to 64 t/ha with a mean gypsum content of about 13.4 t/ha.

A geostatistical method was used to examine the spatial dependence of the variability of the soil properties. This involved deriving a semi-variogram to determine the degree of spatial dependence between neighboring observations. Due to substantial variation between the smallest sampling intervals (i.e., 5 m), spatial dependence was not apparent for most soil parameters. Two properties, however, extractable calcium from the B horizon and depth of the B horizon, did show strong spatial dependence. Samples derived within 15 to 20 m of each other appear to be related. The study suggests that due to the extreme variability encountered in Solonetzic soils, high sample numbers will be required to characterize them adequately, and samples should be spaced at least 20 m apart to ensure their mutual independence.

PUBLICATIONS

Research

Caldwell, C. D. 1983. A method for evaluation of cultivar, nitrogen, and PGR effects on cereal straw strength. Can. J. Plant Sci. 63:1067-1070.

Chow, P. N. P.; O'Sullivan, P. A.; Hunter, J. H.; Kirkland, K. J. 1983. Control of barley and wheat in canola with BAS 9052. Can. J. Plant Sci. 63:1099-1102.

Greer, G. G. 1983. Psychrotrophic *Brocothrix thermosphacta* bacteriophages isolated from beef. Appl. Environ. Microbiol. 46:245-251.

Greer, G. G.; Jeremiah, L. E.; Weiss, G. M. 1983. Effects of wholesale and retail contamination on the case life of beef. J. Food Prot. 46:842-845.

Jeremiah, L. E. 1982. The effects of frozen storage and protective storage wrap on the retail caselife of pork loin chops. J. Food Qual. 5:311-326.

Jeremiah, L. E.; Martin, A. H.; Achtymichuk, G. 1983. Effect of delayed chilling on the microbiological quality of beef carcasses. Can. J. Anim. Sci. 63:463-467.

Malhi, S. S.; Nyborg, M. 1983. Field study of the fate of fall-applied 15N-labelled fertilizers in three Alberta soils. Agron. J. 75:71-74.

Malhi, S. S.; Nyborg, M. 1983. Release of mineral N from soils: Influence of inhibitors of nitrification. Soil Biol. Biochem. 15:581-585.

Martin, A. H.; Murray, A. C.; Jeremiah, L. E.; Dutson, P. J. 1983. Electrical stimulation and carcass aging effects on beef carcass in relation to post-mortem glycolytic rates. J. Anim. Sci. 57:1456-1462.

Murray, A. C.; Jeremiah, L. E.; Martin, A. H. 1983. Muscle fibre orientation and its effect on measurements of tenderness of bovine longissimus dorsi muscle. J. Food Technol. 18:607-617.

O'Donovan, J. T.; O'Sullivan, P. A.; Caldwell, C. D. 1983. Basis for antagonism of paraquat phytotoxicity to barley by MCPA dimethylamine. Weed Res. 23:165-172.

O'Sullivan, P. A. 1983. Selective control of false cleavers in rapeseed with benazolin. Can. J. Plant Sci. 63:497-501.

O'Sullivan, P. A. 1983. Influence of picloram alone or plus 2,4-D on control of wild oats *Avena fatua* with four post-emergence herbicides. Weed Sci. 31:889-891.

O'Sullivan, P. A.; O'Donovan, J. T.; Weiss, G. M. 1983. Influence of stage of application of Glyphosate and Paraquat with and without Tween 20 on the control of annual grass species. Can. J. Plant Sci. 63:1039-1046.

Piening, L. J.; Walker, D. R.; Dagenais, M. 1983. Effect of fertilizer on root rot of barley on stubble and fallow land. Can. J. Plant Pathol. 5:136-138.

Piening, L. J. 1983. Effects of seed spacing on common root rot of some barley cultivars. Can. J. Plant Sci. 63:611-616.

Piening, L. J.; Duczek, L. J.; Atkinson, T. G.; Davidson, J. G. N. 1982. Control of common root rot and loose smut and the phytotoxicity of seed treatment fungicides on Gateway barley. Can. J. Plant Pathol. 5:49-53.

Rahnefeld, G. W.; Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A. 1983. Sex and year effects on carcass characteristics of three-way cross beef cattle reared at two locations. Can. J. Anim. Sci. 63:285-298.

Rahnefeld, G. W.; Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A. 1983. Breed of terminal sire effects on carcass characteristics of three-way cross beef cattle reared at two locations. Can. J. Anim. Sci. 63:523-549.

Sather, A. P.; Fredeen, H. T. 1982. The effect of confinement housing upon the incidence of leg weakness in swine. Can. J. Anim. Sci. 62:1119-1128.

Sharma, M. P.; McBeath, D. K.; Vanden Born, W. B. 1983. Effect of fall and spring tillage on wild oat germination. Can. J. Plant. Sci. 63:561-562.

Tong, A. K. W. 1983. Breed averages and age of dam adjustment factors for birth weight of beef cattle. Can. J. Anim. Sci. 63:7-15.

Tong, A. K. W.; Newman, J. A.; Martin, A. H.; Fredeen, H. T. 1983. The joint influences of equipment and operator on ultrasonic rib fat measurements for prediction of beef carcass composition. Can. J. Anim. Sci. 63:315-324.

Miscellaneous

Berkenkamp, W. B.; Ellis, P. 1983. Alfalfa yield losses due to disease. Canadex 632.121.

Doornenbal, H. 1983. Using physiological parameters in animal production. Canadex, September 1983.

Fredeen, H. T.; Harmon, B. G. 1983. The swine industry: Challenges and changes. Invitational paper, annual meeting, ASAS. J. Anim. Sci. 57(Suppl. 2):100-118.

Fredeen, H. T. 1983. Breeding programs for a commercial cow–calf herd; contribution to Symposium on Herd Health Management. Vet. Clin. North Am. Large Anim. Pract. 5:103-117.

Jeremiah, L. E. 1983. Consumer selection criterion for beef in central Alberta. Can. Agric. 29(l):30-31.

Martin, A. H.; Murray, A. C.; Jeremiah, L. E. 1982. Evaluation of two experiments involving electrical stimulation of beef carcasses in relation to post-mortem glycolytic rates. J. Anim. Sci. 55(Suppl. l):250.

Murray, A. C. 1982. Porcine stress and pork quality. Can. Agric. 27:18-21.

Piening, L. J. 1983. Root rots of barley. Canadex 114. 632.

Research Station

Lethbridge, Alberta

PROFESSIONAL STAFF

D. G. Dorrell, B.S.A., M.Sc., Ph.D.	Director
D. B. Wilson, B.Sc., M.S., Ph.D.	Acting Assistant Director
S. B. Arnason, B.S.A.	Head, Administration
C. G. Schoening	Finance Officer
M. J. McCormick, B.A.	Personnel Officer
W. H. Mains, M.S.A.(Eng.)	Facilities Management Engineer

Scientific Support

C. M. Cutler, B.A., M.L.S.	Area Coordinator, Library
B. S. Freeze, B.S.A., M.Sc.	Bioeconomist
G. K. Honey, B.S.A.	Technical Information Officer
G. C. Kozub, B.Sc., M.Sc.	Statistician
R. B. Peveril,[1] B.Sc.	Computer System Manager
C. M. Ronning Mains, B.A., B.L.S.	Librarian Statistician
L. J. L. Sears, B.A.	Scientific Editor

Animal Parasitology

W. O. Haufe, B.A., M.Sc., D.I.C., Ph.D.	Head of Section; Bioclimatology
R. W. Baron, B.Sc., Ph.D.	Immunology
M. A. Khan, G.V.Sc., M.S., Ph.D.	Toxicology
R. H. Robertson, B.A., M.Sc.	Serology
J. A. Shemanchuk, C.D., B.Sc., M.Sc.	Biting-fly ecology
J. L. Shipp, B.Sc., M.Sc., Ph.D.	Black fly ecology
W. G. Taylor, B.S.P., Ph.D.	Pesticide chemistry
J. Weintraub, B.A., M.S.	Cattle grub ecology
P. R. Wilkinson, B.A., M.A., Ph.D.	Tick ecology and control

Animal Science

E. E. Swierstra, B.S.A., M.S.A., Ph.D.	Head of Section; Reproductive physiology

C. B. M. Bailey, B.S.A., M.S.A., Ph.D.	Animal physiology
K.-J. Cheng, B.Sc., M.Sc., Ph.D.	Rumen microbiology
G. H. Coulter, B.Sc., Ph.D.	Reproductive physiology
G. A. Grigat, B.Sc., Ph.D.	Animal nutrition
R. Hironaka, B.Sc., M.Sc., Ph.D.	Animal nutrition
J. E. Lawson, B.S.A., M.S.A.	Beef cattle breeding
L. A. McClelland, B.Sc., M.Sc.	Sheep breeding
G. J. Mears, B.Sc., M.Sc., Ph.D.	Animal physiology
R. C. Phillippe, B.Sc.	Bacterial culture collection
J. A. P. Vesely, B.S.A., M.S.A., Ph.D.	Sheep and dairy cattle breeding

Crop Entomology

D. L. Struble, B.A., M.A., Ph.D.	Acting Head of Section; Insect attractants
J. R. Byers, B.S.A., M.Sc., Ph.D.	Cutworm ecology
W. A. Charnetski, B.Sc., M.Sc., Ph.D.	Insecticides
A. M. Harper, B.Sc., M.Sc., Ph.D.	Aphids
B. D. Hill, B.Sc., M.Sc., Ph.D.	Residue chemistry
D. L. Johnson, B.Sc., M.Sc., Ph.D.	Rangeland insects
K. W. Richards, B.Sc., M.Sc., Ph.D.	Insect pollinators
B. D. Schaber, B.Sc., M.Sc., Ph.D.	Forage crop pests
G. H. Whitfield, B.Sc., M.Sc., Ph.D.	Potato and sugar beet pests

Plant Pathology

F. R. Harper, B.Sc., M.Sc., Ph.D.	Head of Section; Cereal leaf diseases
R. L. Conner, B.S.A., Ph.D.	Cereal diseases
D. A. Gaudet, B.Sc., M.Sc., Ph.D.	Snow molds
H.-C. Huang, B.Sc., M.Sc., Ph.D.	Forage and special crops diseases
G. A. Nelson, B.Sc., M.Sc., Ph.D.	Potato and bacterial diseases
D. W. A. Roberts, B.A., Ph.D.	Cold-hardiness physiology

Plant Science

S. Smoliak, F.S.R.M., B.Sc., M.S.	Acting Head of Section; Dryland pastures
J. R. Allan, B.Sc., M.A., Ph.D.	Aquatic plant physiology
R. E. Blackshaw,[2] B.Sc., M.Sc.	Weed control
M. R. Hanna, B.S.A., M.S.A., Ph.D.	Forage legume breeding
M. S. Kaldy, B.Sc., M.S., Ph.D.	Food science
G. A. Kemp, B.Sc., Ph.D.	Vegetable breeding
D. R. Lynch, B.Sc., M.Sc., Ph.D.	Potato breeding
M. D. MacDonald, B.Sc., Ph.D.	Corn breeding
D. J. Major, B.Sc., M.Sc., Ph.D.	Crop physiology
K. W. May, B.Sc., M.Sc., Ph.D.	Barley breeding
R. J. Morrison, B.Sc., Ph.D.	Spring wheat breeding
J. R. Moyer, B.Sc., M.Sc., Ph.D.	Weed control

H.-H. Mündel, B.S.A., M.S., Ph.D.	New crops
J. B. Thomas, B.Sc., M.Sc., Ph.D.	Winter and soft white spring wheat breeding
E. D. P. Whelan, B.S.A., M.S.A., Ph.D.	Wheat cytogenetics
W. D. Willms, B.S.F., M.Sc., Ph.D.	Rangeland ecology

Soil Science

D. C. MacKay, B.Sc., M.S., Ph.D.	Head of Section; Plant nutrition
G. J. Beke, B.S.A., M.Sc., Ph.D.	Hydrology
J. B. Bole, B.S.A., M.Sc., Ph.D.	Plant nutrition
J. M. Carefoot,[3] B.S.A., M.S.A.	Chemical analyses
C. Chang, B.Sc., M.Sc., Ph.D.	Soil physics
J. F. Dormaar, B.S.A., M.S.A., Ph.D.	Organic chemistry
S. Dubetz, B.Sc., M.S.	Irrigation agronomy
N. Foroud, B.Sc., M.Sc., Ph.D.	Irrigation engineering
B. W. Grace, B.Sc., M.Sc., Ph.D.	Agrometeorology
R. M. N. Kucey, B.Sc., Ph.D.	Soil fertility
C. W. Lindwall,[4] B.Sc., M.Sc., Ph.D.	Agricultural engineering
R. J. Rennie, B.S.A., M.Sc., Ph.D.	Soil microbiology
T. G. Sommerfeldt, B.Sc., M.S., Ph.D.	Drainage engineering

Departures

T. G. Atkinson, B.S.A., M.Sc., Ph.D. Resigned 31 August 1983	Assistant Director
K. J. Degenhardt, B.Sc., M.Sc., Ph.D. Resigned 15 July 1983	Smuts and oilseed diseases
S. McDonald, C.D., B.Sc., M.Sc. Retired 26 August 1983	Head of Section; Crop entomology
J. P. Miska, B.A., B.L.S. Resigned 30 September 1983	Library Area Coordinator

VISITING SCIENTISTS

P. E. A. Asea, M.Sc. International Atomic Energy Agency training fellow, July 1982 to June 1983	Plant nutrition
G. E. S. Diab, Ph.D. Visiting Research Fellow, Canadian International Development Research Centre, April 1983 to March 1984	Soil fertility
M. Elegba, Dip. C & G International Atomic Energy Agency training fellow, April 1983 to March 1984	Nitrogen fixation

H. Kudo, D.V.M., M.V.S., Ph.D. Postdoctorate fellow, September 1981 to September 1985	Rumen microbiology
W. S. Procunier, Ph.D. Postdoctorate fellow, May 1982 to April 1984	Cytogenetics
P. J. Scholl, Ph.D. Seconded from United States Department of Agriculture to the Canada/USA sterile insect release project on warble flies, March 1982 to February 1987	Integrated pest management and warble fly ecology

---

[1] Seconded from Systems and Consulting Division, Finance and Administration Branch, Agriculture Canada.
[2] On educational leave, University of Guelph, January 1983 to January 1986.
[3] On educational leave, University of Alberta, September 1982 to August 1985.
[4] On educational leave, Iowa State University, Ames, IA, August 1980 to August 1983.

INTRODUCTION

The Research Station at Lethbridge, in southern Alberta, is located at the center of one of the most diverse agricultural regions in Canada. A wide variety of crops is grown on both dry and irrigated land and a major part of Canada's beef cattle industry is established on the farms and ranches within and around the region.

Station scientists conduct fundamental and applied research in six disciplines to support 13 Research Branch objectives. In addition to the 500-ha site at Lethbridge, the Station conducts research at a 17 000-ha ranch and beef cattle breeding station near Manyberries, a 400-ha ranch near Stavely in the foothills of the Rocky Mountains, and a 130-ha irrigation substation at Vauxhall.

Crop production and improvement research deals with the breeding and genetics of 12 different species or crop kinds, the study of the biology and control of a wide range of plant diseases and insect pests, and the development of improved agronomic practices related to soil fertility, tillage, and water use. Related studies on physical, chemical, microbiological, and hydrological aspects of soil provide guidance for the introduction of methods to maintain or improve the soil resource.

Livestock breeding research is concerned with evaluating the effects of breed and selection methods on the improvement of beef and dairy cattle, and breed and breeding management on sheep productivity. Other studies on nutrition and physiology contribute to the development of efficient methods of beef cattle production. The Station is also a major center for the study of arthropod pests of livestock.

During 1983 Mr. S. McDonald, Head of the Crop Entomology section, retired, Dr. T. G. Atkinson, Assistant Director, left to become Director of the Winnipeg Research Station, and Dr. K. J. Degenhardt, Cereal Pathologist, resigned. Important new research in agrometeorology and economics was initiated with the appointment of two new staff members.

The short reports that follow give results of some recent research and illustrate the types of studies that are under way. Further information may be obtained from publications listed at the end of the report or from the scientists. Correspondence or requests for reprints should be addressed to the Research Station, Agriculture Canada, Lethbridge, Alta. T1J 4B1.

D. G. Dorrell
Director

ANIMAL PARASITOLOGY

Biting flies

Cytogenetics of black flies. With the aid of a technique for staining adult polytene chromosomes from malphigian tubules and larval polytene chromosomes from salivary glands, one cattle pest sibling of the *Simulium arcticum* complex has been definitely identified. This pest sibling occurred in the Athabasca River in three distinct peaks during the 1983 season. Nine other siblings of the *S. arcticum* complex have been identified from tributaries of the Athabasca River and from some rivers, creeks, and irrigation canals in southern Alberta. The pest status of these siblings is unknown at present. Results of this study indicate that siblings of the *S. arcticum* complex have definite habitat preferences, e.g., siblings that occur in the tributaries of the Athabasca River are different from the siblings that occur in the Athabasca River downstream from the town of Athabasca.

Black fly egg sampling. Three sizes of Plexiglas samplers (0.09, 0.37, and 0.84 m^2) were evaluated as a means of intercepting and collecting "newly" oviposited black fly eggs in the Athabasca River. Samplers were placed 3, 6, and 9 m from shore. Ninety-two percent of the eggs were collected by samplers that were placed 3 m from shore with the 0.09 m^2 size collecting most of the eggs. The Plexiglas sampler is most effective when the water velocity is less than 30 cm/s. This situation occurs only within a few metres off shore in the "calm" sections of the Athabasca River when the water level is low. Thus, the use of a Plexiglas plate as an interceptor type of sampler is not practical for the Athabasca

River because the river level changes too rapidly. But, these samplers may be very useful for collecting black fly eggs, especially of *Simulium arcticum* Malloch, in the slower, smaller rivers and creeks.

Horn fly control and productivity in cow–calf operations. Ear tags impregnated with fenvalerate and used to control horn flies in cow–calf operations were found to increase cattle productivity significantly on large ranches. When other management procedures were fully integrated for optimum efficiency of the ear tags in the grazing operation, calves increased their preweaning rate of weight gain by 16–23% over untreated cattle during a 113-day grazing period. Cows with the ear tags also increased their body weight to time of weaning by an average of 11% over untreated ones. The study showed that, to realize the improved productivity, use of ear tags must be integrated with other management procedures to achieve and maintain eradication of biting flies throughout the grazing period.

Horn fly control with permethrin. A pour-on or spray application of permethrin, applied to yearling steers, had a quick and highly toxic but not a repellent effect on horn flies. The flies were able to land but not rest or feed on the treated steers. During 15 days post-treatment, all the 813 horn flies exposed to the sprayed steers died without taking a blood meal. During the same period, all but two of 1426 horn flies exposed to the steer treated with the pour-on application died, and only one living and seven of the dead horn flies had taken a blood meal.

Cattle lice

Louse control. Fenvalerate ear tags, used at the rate of two tags per head, were effective for gradual but 100% control of chronic, heavy infestation with the shortnosed cattle louse on habitually lousy, pregnant, range cows. Louse control was 51, 84, 91, and almost 100% at 2, 4, 8, and 16 wk post-treatment. No lice were found on the treated cows from week 17 post-treatment to the end of the experiment at 21 wk post-treatment. The treatment had no adverse effects on the health of the cows.

House flies

Biological control. The parasitic wasp *Muscidifurax raptor* provided effective control of house flies breeding in dairy barns and dramatically reduced the resident house fly infestation over the spring and summer months. In piggeries, this biological control agent did not eliminate the fly infestation entirely. When fly releases were stopped, the fly infestations increased to previous levels despite continuing use of insecticides.

Sheep keds

Immune responses. Antibody appears to have a minor role in the development of acquired resistance to *Melophagus ovinus*, the sheep ked, because the response is very transient. The primary and secondary antibody responses of ked-infested sheep were followed using the enzyme-linked immunosorbent assay (ELISA) technique. Both responses closely followed the rise and fall of ked numbers in both resistant and susceptible sheep. The peak antibody response was attained after 5.5 mo in primary infestations and after 4 mo in secondary infestations. In both cases this coincided with a peak in ked populations.

Oral secretion from keds appears to adversely affect the ability of the sheep's cellular system to respond normally until after the parasite populations have peaked. In vitro blast transformation of lymphocytes from ked-infested sheep stimulated with ked antigen or phytohemagglutinin was suppressed until ked populations began to decline. These results suggest that the sheep ked may be able to enhance its survival by suppressing host immunity.

Ticks

Tick behavior and control. Results from tests with Rocky Mountain wood ticks from the British Columbia interior and from Alberta montane and prairie sites showed a highly significant difference in the ability of female ticks to cause ataxia in lambs. In a related investigation with cattle, ticks from the British Columbia interior and Alberta mountains exhibited a tendency for attachment to the upper parts of the animal's body, i.e., along the backline and neck, whereas ticks from the Alberta prairie exhibited attachment preference for the underside of the animal's body, i.e., along the belly, between the front legs, and brisket. Further study of this geographical variation may suggest ways in which "paralyzing strains" may be rendered harmless by genetic manipulation.

In a cooperative federal–provincial–rancher trial in British Columbia, fenthion spot-treatment of tick attachment sites at the registered dose for warble treatment was ineffective and several animals became paralyzed but recovered. A single injection of ivermectin at a rate of 0.2 mg/kg of body weight slowed tick feeding but failed to protect animals for more than 2 wk. Lindane 0.25% back spray gave season-long protection in the heavily infested experimental field.

Toxicology

Repellents. In vitro metabolism techniques were developed to investigate the degradation and fate of some lipophilic organic pesticides by buffered suspension of liver microsomal enzymes, biochemical cofactors, and oxygen. Liver microsomes from normal (untreated) and barbiturate-pretreated albino rats were utilized to study the metabolic fate of a terpene-based insect repellent, 3-acetyl-2-(2,6-dimethyl-5-heptenyl) oxazolidine (Citronyl, S. C. Johnson and Son). This compound is a semisynthetic derivative of citronellal and shows promise as a biting fly repellent for livestock. At a constant protein concentration, microsomes from phenobarbital-pretreated rats were twice as effective as normal microsomes in degrading this insect repellent. The olefinic functional group in the molecule represented the main site of oxidation. A mixture of four alcohols, possessing both *trans* and *cis* stereochemistry, were identified in post-incubate extracts. These new metabolites were separated and quantified by high resolution gas chromatography with 20–25 m capillary columns. Some *trans* selectivity was evident in the main metabolic pathway. The mean *trans*-to-*cis* alcohols ratio was 70:30 in 47 metabolic extracts.

Warble grubs

Eradication of cattle grubs (*Hypoderma lineatum* and *H. bovis*). A Canada–USA pilot project to evaluate integrated management of sterile warble fly releases and treatment with systemic insecticides began in 1982. A grub-rearing facility was established that produced over 1500 mature grubs of each species from naturally infested calves. The grubs were laboratory-reared to synchronize emergence of sterile flies with natural fly emergence in outdoor plots. Sterile flies, irradiated with 5000 and 8000 rad in the late pupal stage, were released over the appropriate season for each species. Releases were concentrated in the pockets of heavy infestation in Alberta to demonstrate a strategy of sterile fly utilization. Despite the complications of increasing the project's scale over the previous effort on a single ranch, improved procedures have now been established to service the project to conclusion.

ANIMAL SCIENCE

Beef cattle

Feed efficiency of Charolais × Hereford steers. Charolais × Hereford steers with an initial weight of about 250 kg were fed an all-concentrate diet in amounts to obtain low (0.7 kg/day), medium (0.9 kg/day), or high (fed ad libitum) rates of gain. The feeding levels were arranged to provide five feeding programs of LLH, LMH, HML, MMM, and HHH, with the first and second periods of 12 wk duration and the third period of variable length to permit marketing each steer at about 520 kg. Steers on the HHH program consumed the most feed per day, gained the fastest, and required the least time to reach market weight. The digestible energy requirement of 109.4 MJ/kg gain for the HHH steers was similar to that of steers on the LLH program and only marginally greater than that of steers on the LMH, HML, and MMM programs. Steers that were restricted in feed intake during part or all of the experiment had leaner carcasses than those that were fed ad libitum throughout (HHH group). All carcasses of steers that were restricted in feed during part or all of the feeding period graded A1 or A2, whereas 25% of the steers fed ad libitum throughout the feeding period graded A3 (Canadian beef grading standards, Can. Gaz. Part II. 112:2945). An economic comparison was made using combinations of low and high grain-to-forage price ratios, and small and large price differentials between A2 and A3 carcass grades. The LMH program ranked first in net returns, the MMM program ranked second under two economic conditions, and the HHH program ranked second under two other economic situations.

Efficiency of marketing steers at different weights. Hereford and Charolais × Hereford steer calves with average initial weights of about 220 and 265 kg were fed an all-concentrate diet ad libitum. The Hereford steer calves were marketed at about 400, 440, or 475 kg and the Charolais × Hereford steers were marketed at about 525, 570, and 610 kg. As the slaughter weight increased, the digestible energy required per unit gain increased for Hereford steers but not for Charolais × Hereford steers. Within each breed, dressing percentage, rib eye area, and backfat thickness increased as slaughter weight increased. Among Hereford steers, average carcass grade scores at the two lowest carcass weights were similar and lower (leaner carcasses) than scores at the high carcass weight (Canadian beef grading standards, Can. Gaz. Part II. 112:2945). Among Charolais × Hereford steers, the carcass grade was not influenced by slaughter weight. Slaughtering Hereford and Charolais × Hereford steers at light weights is not an assurance that all carcasses will be lean enough to grade A1 or A2 when fed a high concentrate diet ad libitum from weaning to slaughter.

Rumen microbiology. Three distinct bacterial populations have been defined in the bovine rumen—the rumen fluid population, the population associated with feed particles, and the population adherent to the rumen epithelium. Alkaline phosphatase activity has been reported in cells of all three populations. The reaction product technique was used to localize the alkaline phosphatases in the stratified squamous epithelium and the adherent bacteria. Alkaline phosphatase activity in tissue samples with adherent bacteria was higher in the rumen than in the abomasum. Alkaline phosphatase activities were higher for bulls fed a high energy diet than for bulls fed a medium energy diet. Morphological studies showed that rumen epithelial samples from animals fed a high energy diet exhibited a more widely distributed alkaline phosphatase activity and increased "pitting" of the epithelial tissue compared with bulls fed medium energy diets. The higher alkaline phosphatase activity of the epithelial tissue of animals fed the high energy diet may be explained by the greater rates of cell death and renewal. These are indicated by the high mitotic index reported by other researchers who have studied the cell cycle of the rumen epithelium in ruminants fed high and low energy diets.

Microbial degradation of mimosine in cattle and sheep. Leucaena leucocephala is a leguminous forage and is potentially an excellent source of crude protein. Its use as an all-purpose livestock feed has been limited by the presence of mimosine, a toxic nonprotein amino acid that causes low weight gain, general poor condition, and hair loss in ruminants and nonruminants. Our in vitro studies showed that mimosine was degraded by mixed rumen microorganisms from cattle and sheep. The toxic amino acid was degraded more rapidly by rumen microorganisms from sheep on a concentrate diet (average rate 2.17 μg/mL per hour) than by rumen organisms from sheep on cubed hay (0.44 μg/mL per hour). Mimosine was also metabolized by rumen organisms from steers on concentrate rations (2.88 μg/mL per hour) but in vitro rates were lower when inocula originated from cattle fed hay, pasture, or silage diets (<1.87 μg/mL per hour). In both cattle and sheep, rates of degradation were more rapid at early stages of incubation. Our results indicate that mimosine detoxification is enhanced by rumen microbiota from sheep and cattle on concentrate diets.

Sheep

Effect of monensin on rumen metabolism, coccidial infestation and feed efficiency of feedlot lambs. Monensin was fed to naturally reared lambs, most of which were infested with coccidia, and to coccidia-free, vivarium-reared lambs. Increases in feed efficiency (5–11.8%) were only seen in the coccidia-infested, naturally reared lambs even though the most pronounced alterations in the pattern of volatile fatty acid production (propionate increased and acetate decreased) were seen in the coccidia-free, vivarium-reared lambs. Monensin treatment (25 ppm in feed) completely eradicated coccidia from infested animals, and we suggest that the control of coccidial infestation accounts for part of the increase in feed efficiency. These findings suggest that monensin will be most effective in improving feed efficiency when lambs are infested with coccidia.

CROP ENTOMOLOGY

Cutworms

Population monitoring. Population levels of eight noctuid species at 81 locations in a 13 000 km^2 region of southern Alberta were determined for the 6th yr, using sex attractant traps. The relationship between moth catches and subsequent larval infestations continued to be encouraging. All infestations have occurred near locations where moth catches were high. The approximate thresholds (moths per trap) for the most important pest species are as follows: pale western cutworm, 250; redbacked cutworm, >1200; army cutworm, >1000; darksided cutworm, >1000; bertha armyworm, 200 (in traps adjacent to canola fields). At these levels, minor to moderate damage might occur, depending on factors affecting larval survival and crop growth.

The pale western cutworm was the only species that exceeded the threshold level in 1983. Moth catches of this species were 56% higher than in 1982 and exceeded 250 per trap at 21 of the monitoring locations. The 1982 population of moths produced larval infestations in the spring of 1983 and 6000 ha within the survey area required insecticide treatment. Pale western cutworm has shown a progressive increase over the past 6 yr and could be a serious problem in southern Alberta if the spring of 1984 is favorable for cutworm survival, i.e., warm and dry.

Alfalfa leafcutter bees

Management. The loose-cell system of alfalfa leafcutter bee management enables beekeepers to control parasites and predators of the bee by using various procedures for hive construction, incubation, removal, and tumbling of cells from the hives. Tumbling the loose cells in a cylindrical tumbler after they have been removed from the grooved boards removes loose leaf pieces, debris, plant foliar molds, some insects that feed on debris, and insects that are predators of the bee. The effectiveness of a hand-cranked tumbler and five motor-driven tumblers were investigated. The hand-cranked tumbler removed more debris and pest insects than did the motor-driven tumblers. A positive linear relationship exists between the initial sample weights and the amount of material removed during tumbling; however, the relative efficiency of each tumbler decreased as the load of bee cells increased.

Parasitism. An increasing problem in Canada is the parasitism of leafcutter bee cocoons by the chalcidoid, *Pteromalus venustus*. The feasibility of using dichlorvos resin strips to control this parasite during incubation of the cocoons was investigated. To eliminate parasitism completely, the chalcidoid must be controlled within 2–4 h of its emergence from infected cocoons. Dichlorvos resin strips gave partial control of the emerging parasites and the survival of the leafcutter bees was significantly increased at rates of 0.71 and 0.99 strip per 28.3 m^3 of incubator volume. The preferred rate was 0.71 strip per 28.3 m^3. Adult parasites were placed in three different housing environments and exposed to the 0.71 strip per 28.3 m^3 rate. If the parasites were directly exposed to the dichlorvos vapor, mortality occurred within 2 h. If the parasites were shielded by layers of cocoons, mortality occurred in 7–10 h. Because of this shielding effect, it may be advantageous to use dichlorvos resin strips in combination with a method to attract the parasites out of the cocoons.

Pest insects. Larval infestations of the driedfruit moth, *Vitula edmandsae*, were discovered recently in leafcutter bee hives and hive storage buildings. Larvae invade the hive tunnels where they destroy the bee larvae and cocoons, and damage the polystyrene nesting material to the extent that it cannot be used again. This species is also a known pest of honey bee combs. A sex pheromone monitoring or control system for the driedfruit moth was developed through the identification of 16 “pheromone-like” compounds that were isolated from the female moths. A four-component synthetic pheromone blend, based on the naturally occurring pheromone components, was optimized for the attraction of male moths. This pheromone blend will be useful as a trap bait for monitoring the occurrences and abundances of the driedfruit moth, so that early control measures may be implemented by producers. There is potential for using the pheromone blend to control this pest by mass trapping within hive storage buildings.

Forage crop insects

A new, relatively large, nesting area was discovered for an alfalfa weevil predator, *Odynerus dilectus*, a solitary wasp. Behavior studies of this predator can now be conducted to verify observations that were previously done on a few individual nesting sites. Each female wasp provisions a cell with about 25 alfalfa weevil larvae, and they average a collection trip every 7 min when there are about five weevil larvae per 90° sweep. With culturing and management, this insect may have a potential for biological control of alfalfa weevil.

Pest and predatory insects in alfalfa hay can carry on their bodies spores of *Verticillium albo-atrum*, the causal organism of verticillium wilt of alfalfa. The percentage of insects of each species that were contaminated with spores varied with their stage of development and date of collection. Because spores of *V. albo-atrum* are found on both beneficial and pest insects, biological control of alfalfa pests by predators may have to be reassessed in areas where verticillium wilt is prevalent.

Grasshoppers

Population studies. The survey of adult grasshoppers in early August 1983 indicated that the average number of grasshoppers in forage and cereal crops rose for the fourth consecutive year. The survey covered 131 770 km^2, and indicated an increase in the areas classified as light (1–2.5 grasshoppers per square metre) and moderate (2.5–5 grasshoppers per square metre), and a corresponding decrease in the area for which no grasshopper hazard is expected ($\leq 1/m^2$). Agricultural land classified as having moderate populations increased from 11% of the total area surveyed in 1981 to 19% in 1982, and to 25% in 1983. Severe and very severe categories (5–10/m^2 and $>10/m^2$, respectively) comprised 1% and 3% of the area surveyed in 1983. A warm, exceptionally dry June facilitated high survival and rapid development of grasshopper nymphs. Late hours of sunshine and temperature were above average, allowing very favorable egg-laying conditions for grasshoppers throughout most of Alberta. The effects of low temperatures in early winter (i.e., extended periods of -20 to -30°C) were moderated by snow cover. Consequently, egg survival is expected to be high enough to cause moderate to severe grasshopper hazard, especially in the southwest quarter of the province. Severe infestations that threatened the Peace River area in 1983 were virtually eliminated by excessive precipitation. Populations in the Wainwright–Provost area were reduced, presumably by the interaction of wet weather and fungal pathogens.

Row crop pests

Populations of the sugarbeet root maggot, *Tetanops myopaeformis*, increased in 1983. About 95% of the sugarbeet crop was treated at seeding with granular insecticides, because no controls are currently registered for application to the growing plants. Field tests in 1983 showed that two drench and one granular insecticide formulations provided excellent control of root maggot when applied to the plants. A phenology model based on degree-day accumulation was developed for predicting the emergence time of the adults by studying the effect of temperature on the survival and development of the root maggot in the laboratory. The results were validated by monitoring the emergence of adults in the field. This system will be useful for predicting emergence of adult root maggots for timing insecticide controls.

The European corn borer established near Medicine Hat, Alta., has expanded to the Irvine and Purple Springs areas. An improved sex pheromone system was developed and will be used to follow changes in the infestation area.

PLANT PATHOLOGY

Vernalization of wheat. Winalta and Kharkov 22 MC winter wheats differ in the length of time that their moistened seeds must be exposed to near-freezing temperatures (0–10°C) to satisfy their vernalization requirement for rapid heading. To obtain information on the genetics of this difference in vernalization requirement, Rescue, Winalta, Kharkov 22 MC, and the disomic substitution lines derived by inserting Rescue chromosome 5A into Winalta and Kharkov 22 MC have been vernalized for 0–15 wk and the days to head determined. The results show that chromosome 5A carries the vernalization locus (Vrn_1) and suggest that this locus is responsible for the differences in vernalization responses among Rescue, Winalta, and Kharkov 22 MC.

Cereal diseases

A translocation between winter wheat (*Triticum aestivum* L.) and chromosome 6 of *Agropyron elongatum* (Host) Beauv. conferred resistance to *Eriophyes tulipae* Keifer, the mite vector of wheat streak mosaic virus and the wheat spot mosaic agent. Resistance was dominant. However, transmission ranged from 3 to 9% through the pollen and from 42 to 47% through the oviole. After a series of backcrosses, homozygous resistance to *E. tulipae* was transferred into the winter wheat cultivars Norstar and Winalta.

Snow mold on cereals. In the Peace River region of Alberta, snow molds caused serious economic losses in the fall rye crop in 1983. Between 50 and 80% mortality of plants was observed on fall rye fields surveyed. The cottony snow mold pathogen *Coprinus psychromorbidus* was most commonly isolated from decayed plants. *Plenodomus meliloti*, a low temperature snow mold pathogen of alfalfa, was also frequently associated with snow-molded rye plants. The role of this fungus in reducing winter survival in fall-sown cereals is currently being investigated.

Ergot on cereals. From 1980 to 1983, ergot infection was monitored throughout the growing season by exposing groups of flowering rye plants to natural infection by *Claviceps purpurea* in the field for consecutive 1-wk intervals and then ripening the exposed plants in a greenhouse. In 1980, 1982, and 1983, when surveys indicated low disease levels in commercial cereal fields, infection was recorded in only six of the weekly periods beginning in early or mid-July. However, in 1981, a year with a serious outbreak of ergot in spring-sown cereals, infection occurred during 11 wk starting in early June. From these results it appears that infection of grasses flowering in June is required to provide the buildup of inoculum needed for a serious outbreak of ergot on the later-flowering, spring-sown cereals.

Forage crop diseases

Verticillium wilt of alfalfa. Studies in an isolated alfalfa field revealed that in addition to pest and predatory insects, the alfalfa leafcutter bee, a pollinator, is also a potentially important vector of *Verticillium albo-atrum*, the causal organism of verticillium wilt in alfalfa. Over 69% of the cells produced by leafcutter bees that foraged in the diseased alfalfa field were contaminated by the pathogen. Because leafcutter bee cells are shipped for long distances domestically and internationally, contaminated cells could be an important means of introducing the pathogen into alfalfa production areas currently free from the disease.

Potato diseases

Survival of ring rot bacteria in infected stems and under freezing temperatures. Ring rot bacteria persisted for at least 63 mo in dried potato stems (cultivar Russet Burbank) stored in an unheated machine shed; however, bacteria from these stems incited symptomless infection when inoculated into potato plants. Ring rot bacteria remained infectious for at least 8 mo on dry, contaminated, burlap surfaces subjected to constant temperatures of 5 to −40°C or to a diurnally cycling temperature of 5 to −5°C. These studies demonstrate that, when maintained in the dry state, the ring rot pathogen can remain infectious over the winter even after exposure to extreme freezing temperatures.

PLANT SCIENCE

Field crops

Photoperiod response of crop plants. The photoperiod response characteristics of seven long-day species of crop plants were determined by seeding at 33 biweekly intervals in a greenhouse at Lethbridge. A segmented linear regression analysis was used to estimate the length of the basic vegetative and reproductive phases, the photoperiod sensitivity, and the lowest optimal photoperiod. It was found that the most important photoperiod is on the day of floral initiation. If the plant is old enough and the photoperiod is optimal, initiation will occur but, at certain times of the year, the photoperiod is inhibitory. With this method of experimentation, greenhouses can be used to compare large numbers of genotypes.

Corn

Corn heat units evaluated. A study was conducted at 11 locations across Canada to determine if corn hybrids have different corn heat unit (CHU) requirements in different climates. The study included six hybrids in the 3 yr 1977–1979. Differences in the time between planting and emergence were attributable to slow emergence of two hybrids as well as management and weather factors at different locations. Genotypic differences were expressed mainly in the period between emergence and anthesis. At three locations, 198 more CHU were required than at other locations. In the period from anthesis to 45% ear moisture, two hybrids required more CHU than other hybrids. These extra CHU requirements were not related to hybrid rating, i.e., late-maturing hybrids did not require more CHU to complete the ripening phase. In a comparison of growing degree-days with bases ranging from 5 to 15°C, no one thermal unit had sufficient advantage over the CHU system to warrant its adoption in Canada. Further, calendar days gave the most reliable prediction of the duration of the period from planting to emergence. The period from emergence to 10% anthesis was the least variable of all the stages and could be predicted accurately by any of the thermal methods.

Gibberellins and heterosis in maize. Under controlled environment and/or field conditions, vegetative growth (height, internode length, leaf area, shoot dry weight, grain yield) was greater in an F_1 maize hybrid than in either parental inbred. Endogenous gibberellin-like substances in apical meristem cylinders were also higher in the hybrid than in either inbred, both on a per plant and per gram dry weight basis. There were no apparent qualitative differences in gibberellin-like substances, however. Levels of gibberellin-like substances in all genotypes were highest prior to tassel initiation. Gibberellin-like substances and authentic standards of gibberellin native to maize were compared on gradient-eluted SiO_2 partition and reverse-phase C_{18} high-pressure liquid chromatography columns. No consistent differences in abscisic acid levels of the three genotypes were observed. This correlation of heterosis for endogenous gibberellin-like substances with heterosis for growth suggests that amounts of endogenous gibberellin may be related to hybrid vigor in maize.

Potatoes

Darkening of potatoes. Samples of Russet Burbank potatoes, collected from the major production areas in Alberta, were analyzed for chlorogenic acid content. Chlorogenic acid is known to be associated with the tendency for tuber tissue to darken after cooking. Results indicate a trend for chlorogenic acid content to decrease from north to south. This may be associated with cooler temperatures and higher soil organic matter in the northerly locations.

Improved method for determining free amino acids. A dual column system for the determination of free amino acids in plant extracts was developed. Both columns use Beckman AA-20 resin. All five buffers used are lithium citrate and vary according to pH and ionic strength. The acidic and neutral amino acids are eluted on a long column (resin height 37 cm) with two buffers, whereas the basic amino acids are eluted on a short column (resin height 19 cm) with the remaining three buffers. The dual column method saves about 1.7 h per analysis when compared with the standard single column method with lithium citrate buffers.

Forage crops

Mixed forage seedings provide earlier grazing. Fast-growing forage crops sown with slower-developing species, such as Russian wild rye, will maintain forage production during the first few years after seeding. Studies have shown that slender wheatgrass, pubescent wheatgrass, sweetclover, or fall rye can provide early grazing until the Russian wild rye becomes established. Plots were seeded in early spring, with Russian wild rye in 71-cm row spacings and with each of the faster-growing forages between these rows. Plots of alfalfa and one of Russian wild rye were also seeded between the row spacings to provide a comparison. Fall rye and sweetclover proved to be the most suitable species to seed with Russian wild rye because they had died out in the 3rd yr after establishment. Slender wheatgrass persisted until the 4th yr. Pubescent wheatgrass and alfalfa persisted in the stand for the duration of the 9-yr trial. Fall rye reduced the growth of Russian wild rye during the first 2 yr of the trial but wild rye production equaled that of other plots after the fall rye died out. None of the other companion crops affected the growth of the wild rye. Although slender wheatgrass provided good forage production, it has been credited with poor palatability in tests elsewhere. Pubescent wheatgrass, initially believed to be short-lived, persisted in the stand too long to be a good companion crop. However, there were no differences in the total forage yield of all treatments during the study period except that the alfalfa-seeded plots produced 35% more forage than Russian wild rye seeded alone.

Broadcast seeding requires removal of competition. Experiments were conducted to determine the potential of establishing forages from broadcast seed on overgrazed native grasslands in the foothills region. Results suggest that competition from native vegetation must be eliminated for establishment to occur. This can be done by using a nonselective herbicide (glyphosate) prior to seeding. Alfalfa and smooth bromegrass established most successfully. Cicer milk-vetch, Altai wild rye, streambank wheatgrass, orchardgrass, and timothy showed little promise for establishment from broadcast seed. A light disking after seeding or seeding early in the spring may improve the potential for successful establishment. A test in the greenhouse indicated that seedlings established in sod that was killed with glyphosate were more susceptible to damping-off. Disturbing the soil–litter interface seemed to eliminate that effect.

Aquatic plants

Herbicidal control of aquatic vegetation in rangeland dugouts. In rangeland dugouts, aquatic macrophytes increase stagnation and siltation and recycle nutrients from the dugout hydrosoil to the water column. Subsequently, the growth of filamentous and planktonic algae is stimulated. As aquatic vegetation proliferates, the water quality deteriorates until it becomes unsuitable for livestock watering. The potential stocking rate could be seriously decreased by lack of water. Rangeland dugouts were treated with fall-applied simazine, fall-applied fenac, and spring-applied fluridone. Simazine applied to drained dugouts has proven unsatisfactory. The movement of cattle along the shores tends to disrupt the soil-bound herbicide and either dilutes it or stimulates breakdown. Fenac, when applied in the fall to the exposed shores and the remaining standing water, gave excellent total control of rooted aquatic macrophytes and pondbank grasses and broad-leaved plants. Algae control was excellent the first summer after application and through July of the second summer. Copper sulfate application in late August was necessary the 2nd yr to control planktonic algae. Fluridone applied in early spring, immediately after ice break-up, gave excellent control of rooted aquatic macrophytes for the past two seasons but controlled grasses and broad-leaved plants for only one season. No algae control was evident and copper sulfate was required the first season to control filamentous and planktonic algae.

Weeds

Dandelion control in orchardgrass stands. A 7-yr-old orchardgrass stand with 34 dandelion plants per square metre was treated with 2,4-D and 2,4-D plus dicamba or picloram. The orchardgrass and dandelion yields were measured for 4 yr after treatment. Neutral and acid detergent fiber, P, K, Ca, and Mg content of orchardgrass and dandelions were also measured. Applications of 2,4-D at 1.0 kg/ha in spring and fall reduced dandelion yields by 70% and increased orchardgrass yields by 20%, in the 2nd and 3rd yr after treatment, compared with the untreated check. Although increases in dandelion control with 2,4-D at rates greater than 1.0 kg/ha or with 2,4-D plus dicamba were achieved, additional orchardgrass yields were not obtained with these treatments. Total forage yields (orchardgrass plus dandelions) were not significantly increased by herbicide treatment and the presence of dandelions did not cause deleterious changes in the nutrient composition of orchardgrass hay.

SOIL SCIENCE

Soil–crop relations

Comparison of soil- and foliar-applied phosphate fertilizers. A field experiment was conducted to test the effectiveness of trace amounts of tetrasodium pyrophosphate (NaPP) for increasing the uptake of soil-applied triple superphosphate (TSP), soil and foliar-applied monoammonium phosphate (MAP) and diammonium phosphate (DAP), and foliar-applied ammonium polyphosphate (APP). Soil-applied MAP proved to be the best form and method of applying phosphate fertilizers in this study. MAP uptake was also significantly increased by NaPP addition. TSP proved as effective as MAP without NaPP but did not show a response to NaPP addition. DAP also was not affected by NaPP addition. APP uptake was significantly increased by NaPP addition but the increased P uptake did not result in increased yields.

Production practices for soybeans in southern Alberta. Adapted soybean cultivars, when properly inoculated, matured and produced seed of acceptable yield (2000–2500 kg/ha) and during the first half of May. The crop required irrigation from three to six times during the growing season and responded equally well when the water was applied at soil tensions of 6×10^4 or 3×10^4 Pa (30-cm depth). Granular inoculant placed in the furrow with the seed was a superior method to that of seed-applied inoculant. With this inoculation procedure there were no increases in yield from nitrogen fertilizer applied at rates up to 160 kg/ha.

Integrated soil–crop management for reclamation of saline soils. Installation of a subsurface drainage system improved the waterlogged soil conditions of a saline seep area within 3 yr. The quality characteristics of the saline seepwater have changed little over the 5 yr since installation. The seepwater contains an appreciable amount of nitrate nitrogen, which can be utilized for crop production purposes through irrigation application. One irrigation application of 60 mm of saline water, with electrical conductivity (EC) of 12 dS/m, or less, on a soil with EC of less than 1.5 dS/m did not cause a deleterious salt buildup. The acceptable frequency of such irrigations on the same parcel of land needs to be established. Installation of a subsurface drainage system has resulted in improved soil quality in and immediately below the saline seep area but to varying extents. Flooding of land by spring runoff appears to favor soil reclamation, probably because of increased leaching. Continuous annual cropping of undrained bottomland has resulted in further soil salinization, likely because of raised shallow water tables associated with high levels in the drain-water storage reservoir. Such high reservoir levels can cause subirrigation and soil salinization when perforated flex-tubing is the drain material.

Soil chemistry and microbiology

Effect of cropping on chemical characteristics of water-stable soil aggregates. Long-term (67 yr) cropping of a Dark Brown Chernozemic soil led to a loss in percentage of total water-stable aggregates and a shift in aggregate size distribution. Together with an increase in the 100 μm diameter fraction, there was an increase in the sand component within this fraction. These sand particles are probably held together by alkaline-soluble, acid-insoluble organic matter. Polysaccharides seem to play a major role in maintaining stability of the larger aggregates. The physical and chemical changes associated with cultivation were more pronounced in soils from fallow–wheat rotations than in those from a continuous wheat system.

Effect of soil mycorrhizal fungi on alfalfa growth. Greenhouse experiments were conducted to measure the effect of vesicular–arbuscular mycorrhizal (VAM) fungi on alfalfa growth. In the first experiment, wherein the soil had been previously sterilized to kill the indigenous VAM fungi, inoculation resulted in increased alfalfa growth for the first five harvests giving a combined increase of 18% more dry matter. A negative response was obtained for the final four harvests, presumably because total soil P supply was becoming depleted. Inoculation with VAM fungi resulted in an overall increase in dry matter production of 10% for the experiment.

The second experiment monitored the effect of VAM fungi on alfalfa growth in non-sterilized soil with the added effect of four levels of lime addition. Added VAM fungi stimulated alfalfa dry matter production and P uptake at the higher pH levels of the experiment (6.4–7.5) but not at the lower pH levels (5.4–6.1). This suggested that the added VAM fungi were adapted to higher pH levels, whereas the indigenous VAM fungi were adapted to lower pH levels.

Effects of biocides on N_2-fixation in soybeans. Three seed-applied fungicides (captan, thiram, and carbathiin), four preplant soil-incorporated herbicides (chloramben, linuron, metribuzin, and trifluralin), and one postemergence herbicide (diclofop) had no significant effect on seed yields of soybeans when applied at recommended rates. Thiram and captan at 1.0 g/kg of seed reduced yield of N in shoots at anthesis but, at a reduced rate (0.5 g/ha), thiram actually increased N yield. When applied at proper rates, none of the chemicals interfered with N_2 fixation (as measured by acetylene-reduction or ^{15}N procedures) if a granular inoculant was applied in the seed furrow. However, there were drastic interactions between seed-applied inoculants and seed-applied fungicides.

Irrigation and drainage

Evaluation of low-pressure center-pivot sprinklers. The distribution uniformities of eight low-pressure center-pivot irrigation systems ranged from 0.82 to 0.88 along radial lines and from 0.81 to 0.94 along circular lines. All were above the acceptable minimum of 0.80. However, the depth of application for a single pass of most of the systems ranged from 15 to 25 mm, which is lower than that generally accepted for efficient irrigation. Developers of new systems should consider incorporating variable flows, programmed rotational speed, adjustable nozzle height, and an automated method for orientation of nozzles and/or deflectors to compensate for wind distortion.

Irrigation with municipal and industrial waste water. Forage plots were irrigated with municipal waste water or with industrial waste water high in nutrients and organic carbon from a rendering plant. Additional fertilizer N was required to obtain maximum reed canarygrass yields of 10 t/ha even when more than 100 cm of municipal waste water was applied annually. Long-term average alfalfa yields of 10 t/ha were obtained with 50 cm of waste water with no increase from additional fertilizer or waste water. Application of only 10 cm of rendering plant waste water supplied about double the amount of N taken up by reed canarygrass. When supplemented with irrigation water this doubled the yield of the grass receiving only water but had little effect on the yield of irrigated alfalfa. The 10-cm rate of rendering plant waste water led to a buildup of about 200 kg/ha of NO_3-N in the soil to a depth of 3 m in 6 yr. About 1700 kg/ha accumulated when 20 cm/yr of waste water was applied and 2500 kg/ha accumulated when a similar amount of N was applied as fertilizer with irrigation water. Substantial denitrification losses of 50 to 60% of ^{15}N-labeled fertilizer were measured over 2 yr with municipal waste water-irrigated alfalfa, compared with 30% N losses with reed canarygrass. Even greater losses (70% of waste water-N and 50% of fertilizer-N) were measured when the N treatments were applied to reed canarygrass at rates of four times crop uptake.

A simple method for determining total dissolved salts of sulfate-dominant soil extracts. Simple equations for accurate estimation of total dissolved salts (TDS) from electrical conductivity (EC) measurements (ranging from 0 to 16 mS/cm) were developed for sulfate-rich soils in southern Alberta. Soil extracts were obtained by the saturation extract method from 879 samples. EC and TDS in the solution (by summation of the ions) were determined. Several regression equations were fitted. The following equation is recommended for estimating TDS (in milligrams per litre): $TDS = 765.1\ EC^{1.087}$.

Mole drainage for specific waterlogged soils. Laboratory and field studies were carried out to determine the effects of soil texture, soil moisture, and plastic lining on the performance and durability of mole drains. For effective, durable drains, the soil should contain sufficient clay to be cohesive and plastic (i.e., clay loam or finer texture) and the moisture content should be at or above that of the plastic limit (50% of field capacity) during installation. Both the unlined and lined mole drains were operative throughout the 10-yr study and were effective in lowering the water table after each flooding event. However, discharge from the unlined moles averaged 24% of that from the lined. These studies demonstrate that mole drainage can be effectively used to drain waterlogged and saline soils, provided that soil conditions and moisture content at the time of installation are suitable.

PUBLICATIONS

Research

Ayre, G. L.; Turnock, W. J.; Struble, D. L. 1983. Spatial and temporal variability in sex attractant trap catches of *Leucania commoides* and *Peridroma saucia* (Lepidoptera: Noctuidae) in relation to their biology in Manitoba. Can. Entomol. 115:1573-1582.

Batra, T. R.; McAllister, A. J.; Chesnais, J. P.; Darisse, J. P. F.; Emsley, J. A. B.; Lee, A. J.; Roy, G. L.; Vesely, J. A.; Winter, K. A. 1983. Comparison of the heifer reproduction traits of the daughters of several sire groups. Can. J. Anim. Sci. 63:269-278.

Bide, R. W.; Bowden, D.; Tumbleson, M. E. 1983. Sources of normal variation of plasma L-aspartate:2-oxoglutarate aminotransferase in Hereford range cattle. Int. J. Biochem. 15:167-177.

Bole, J. B.; Rennie, R. J. 1983. Comments on paper: "Estimation of nitrogen fixation by isotope dilution in field and greenhouse experiments" by Broadbent *et al.* Agron. J. 75:717.

Chang, C.; Sommerfeldt, T. G.; Carefoot, J. M.; Schaalje, G. B. 1983. Relationships of electrical conductivity with total dissolved salts and cation concentration of sulfate-dominant soil extracts. Can. J. Soil Sci. 63:79-86.

Darcel, C. Le Q.; Kaldy, M. S. 1983. On the possible presence of β_2-microglobulin-like protein in extracts of livers from normal chickens and chickens with erythroblastosis—II. Amino acid analysis of the protein. Comp. Biochem. Physiol. 74B:231-234.

Degenhardt, K. J.; Harper, F. R.; Atkinson, T. G. 1982. Stem smut of fall rye in Alberta: Incidence, losses, and control. Can. J. Plant Pathol. 4:375-380.

Dormaar, J. F. 1983. Aliphatic carboxylic acids in buried Ah horizons in Alberta, Canada, as paleoenvironmental indicators. Can. J. Earth Sci. 20:859-866.

Dormaar, J. F.; Lutwick, L. E. 1983. Extractable Fe and Al as an indicator for buried soil horizons. Catena 10:167-173.

Dormaar, J. F.; Sauerbeck, D. R. 1983. Seasonal effects on photoassimilated carbon-14 in the root system of blue grama and associated soil organic matter. Soil Biol. Biochem. 15:475-479.

Dubetz, S.; Major, D. J.; Rennie, R. J. 1983. Production practices for early maturing soybeans in southern Alberta. Can. J. Plant Sci. 63:641-647.

Dyck, G. W.; Swierstra, E. E. 1983. Growth of the reproductive tract of the gilt from birth to puberty. Can. J. Anim. Sci. 63:81-87.

Fay, J. P.; Cheng, K.-J.; Costerton, J. W. 1983. Effects of breed, diet and sex on the alkaline phosphatase activity in walls of the bovine rumen and abomasum. J. Anim. Sci. 56:1427-1433.

Freyman, S.; Schaalje, G. B. 1983. Harmful effect of worked-down winter wheat on spring-seeded wheat and rapeseed. Can. J. Plant Sci. 63:299-301.

Grigat, G. A.; Mathison, G. W. 1983. Thiamin and magnesium supplementation of all-concentrate diets for feedlot steers. Can. J. Anim. Sci. 63:117-131.

Grigat, G. A.; Mathison, G. W. 1983. A survey of the thiamin status of growing and fattening cattle in Alberta feedlots. Can. J. Anim. Sci. 63:715-719.

Hanson, C. L.; Wight, J. R.; Smith, J. P.; Smoliak, S. 1982. Use of historical yield data to forecast range herbage production. J. Range Manage. 35:614-616.

Hardman, J. M.; Mukerji, M. K. 1982. A model simulating the population dynamics of the grasshoppers (Acrididae) *Melanoplus sanguinipes* (Fabr.), *M. packardii* Scudder, and *Camnula pellucida* (Scudder). Res. Popul. Ecol. 24:276-301.

Harper, A. M.; Freyman, S. 1983. Cold-hardiness of 1-, 2-, and 3-year-old alfalfa infested with the pea aphid (Homoptera: Aphididae). Can. Entomol. 115:1243-1244.

Hobbs, E. H.; Muendel, H.-H. 1983. Water requirements of irrigated soybeans in southern Alberta. Can. J. Plant Sci. 63:855-860.

Huang, H. C. 1983. Histology, amino acid leakage, and chemical composition of normal and abnormal sclerotia of *Sclerotinia sclerotiorum*. Can. J. Bot. 61:1443-1447.

Huang, H. C.; Harper, A. M.; Kokko, E. G.; Howard, R. J. 1983. Aphid transmission of *Verticillium albo-atrum* to alfalfa. Can. J. Plant Pathol. 5:141-147.

Huang, H. C.; Kokko, E. G. 1983. A simple technique for observation and photography of verticillate conidiophores in situ using a stereomicroscope. Can. J. Plant Pathol. 5:36-37.

Kaldy, M. S.; Darcel, C. Le Q. 1983. On the possible presence of a β_2-microglobulin-like protein in extracts of livers from normal chickens and chickens with erythroblastosis—IV. Homology of small molecular weight (mol. wt 11,000) protein with serum albumin based on the content of amino acid residues. Comp. Biochem. Physiol. 75B:399-404.

Kaldy, M. S.; Lynch, D. R. 1983. Chlorogenic acid content of Russet Burbank potato in Alberta. Am. Potato J. 60:375-377.

Kucey, R. M. N. 1983. Phosphate-solubilizing bacteria and fungi in various cultivated and virgin Alberta soils. Can. J. Soil Sci. 63:671-678.

Kucey, R. M. N.; Paul, E. A. 1983. Vesicular arbuscular mycorrhizal spore populations in various Saskatchewan soils and the effect of inoculation with *Glomus mosseae* on faba bean growth in greenhouse and field trials. Can. J. Soil Sci. 63:87-95.

Lin, C. Y.; Batra, T. R.; McAllister, A. J.; Darisse, J. P. F.; Lee, A. J.; Roy, G. L.; Vesely, J. A.; Winter, K. A. 1983. Differences between sire groups in body measurements and body weight changes of lactating cows. Can. J. Anim. Sci. 63:27-37.

Lynch, D. R.; Tai, G. C. C.; Young, D. A.; Schaalje, G. B. 1983. Effect of selecting potato seedlings under maritime conditions on the performance of the first clonal generation under prairie conditions. Am. Potato J. 60:607-615.

Mains, W. H.; Major, D. J. 1983. Adaptation of a forage harvester for harvesting small plots. Can. J. Plant Sci. 63:1057-1060.

Majak, W.; Cheng, K.-J. 1983. Recent studies on ruminal metabolism of 3-nitropropanol in cattle. Toxicon, Suppl. 3:265-268.

Majak, W.; Howarth, R. E.; Cheng, K.-J.; Hall, J. W. 1983. Rumen conditions that predispose cattle to pasture bloat. J. Dairy Sci. 66:1683-1688.

Major, D. J. 1983. Determination of photoperiod response characteristics using a greenhouse. Int. J. Biometeorol. 27:117-124.

Major, D. J.; Brown, D. M.; Bootsma, A.; Dupuis, G.; Fairey, N. A.; Grant, E. A.; Green, D. G.; Hamilton, R. I.; Langille, J.; Sonmor, L. G.; Smeltzer, G. C.; White, R. P. 1983. An evaluation of the corn heat unit system for the short-season growing regions across Canada. Can. J. Plant Sci. 63:121-130.

McKeague, J. A.; Grant, D. R.; Kodama, H.; Beke, G. J.; Wang, C. 1983. Properties and genesis of a soil and the underlying gibbsite-bearing saprolite, Cape Breton Island, Canada. Can. J. Earth Sci. 20:37-48.

Moyer, J. R.; Dryden, R. D.; Chow, P. N. P. 1983. Fall and spring applications of EPTC and two antidotes for weed control in corn. Can. J. Plant Sci. 63:227-234.

Nelson, G. A.; Kozub, G. C. 1983. Effect of total light energy on symptoms and growth of ring rot-infected Red Pontiac potato plants. Am. Potato J. 60:461-468.

Nelson, W. A.; Bell, J. F.; Stewart, S. J. 1983. *Polyplax serrata* (Phthiraptera: Hoplopleuridae): Effects of cortisone and cyclophosphamide on the acquired resistance response of mice to lice. J. Med. Entomol. 20:551-557.

Rahnefeld, G. W.; Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A. 1983. Sex and year effects on carcass characteristics of three-way cross beef cattle reared at two locations. Can. J. Anim. Sci. 63:285-298.

Rahnefeld, G. W.; Fredeen, H. T.; Weiss, G. M.; Lawson, J. E.; Newman, J. A. 1983. Breed of terminal sire effects on carcass characteristics of three-way cross beef cattle reared at two locations. Can. J. Anim. Sci. 63:523-549.

Rennie, R. J.; deFreitas, J. R.; Ruschel, A. P.; Vose, P. V. 1983. ^{15}N isotope dilution to quantify dinitrogen (N_2) fixation associated with Canadian and Brazilian wheat. Can. J. Bot. 61:1667-1671.

Rennie, R. J.; Kemp, G. A. 1983. N_2-fixation in field beans quantified by ^{15}N isotope dilution. I. Effect of strains of *Rhizobium phaseoli*. Agron. J. 75:640-644.

Rennie, R. J.; Kemp, G. A. 1983. N_2-fixation in field beans quantified by ^{15}N isotope dilution. II. Effect of cultivars of beans. Agron. J. 75:645-649.

Rennie, R. J.; Rennie, D. A. 1983. Techniques for quantifying N_2 fixation in association with nonlegumes under field and greenhouse conditions. Can. J. Microbiol. 29:1022-1035.

Richards, K. W. 1983. Impact of damage by the driedfruit moth, *Vitula edmandsae serratilineella* (Lepidoptera: Pyralidae), a pest of the alfalfa leafcutter bee, *Megachile rotundata* (Hymenoptera: Megachilidae). Can. Entomol. 115:1549-1553.

Rood, S. B; Pharis, R. P.; Koshioka, M.; Major, D. J. 1983. Gibberellins and heterosis in maize. Plant Physiol. 71:639-644.

Smoliak, S.; Johnston, A. 1983. Walsh western wheatgrass. Can. J. Plant Sci. 63:759-761.

Sommerfeldt, T. G. 1983. Soil moisture and texture effects on mole drain stability and on force requirement for installation—A laboratory study. Can. Agric. Eng. 25:1-4.

Sommerfeldt, T. G.; Hendry, M. J.; Chang, C. 1983. Soil properties impeding subsurface drainage of a soil near Vauxhall, Alberta: A case study. Can. Agric. Eng. 25:205-208.

Struble, D. L. 1983. Pheromone traps for monitoring moth (Lepidoptera) abundances: Evaluation of cone-orifice and omni-directional designs. Can. Entomol. 115:59-65.

Struble, D. L. 1983. Sex pheromone components of *Euxoa drewseni*: Chemical identification, electrophysiological evaluation, and field attractancy tests. J. Chem. Ecol. 9:335-346.

Struble, D. L.; Richards, K. W. 1983. Identification of sex pheromone components of the female driedfruit moth, *Vitula edmandsae serratilineella*, and a blend for attraction of male moths. J. Chem. Ecol. 9:785-801.

Taylor, W. G. 1983. Hydroxylation of 3-acetyl-2-(2,6-dimethyl-5-heptenyl) oxazolidine by liver microsomes from male rats. Identification of some isomeric metabolites. Drug Metab. Dispos. 11:404-410.

Thomas, J. B.; Kaltsikes, P. J. 1983. Effect of chromosomes 1B and 6B on nucleolus formation in hexaploid triticale. Can. J. Genet. Cytol. 25:292-297.

Thomas, J. B.; Kaltsikes, P. J.; Shigenaga, S. 1983. Effect of chromosome 1B, chromosome 6B, and low temperature on the frequency of chromosome pairing at first meiotic metaphase in hexaploid triticale. Can. J. Genet. Cytol. 25:278-282.

Traquair, J. A.; Kokko, E. G. 1983. Urediniospore morphology of *Puccinia* species attacking Carduea. Can. J. Bot. 61:2047-2051.

Vesely, J. A.; McAllister, A. J.; Lee, A. J.; Batra, T. R.; Darisse, J. F. P.; Roy, G. L.; Winter, K. A. 1983. Evaluation of cow reproduction in the pureline foundation phase of the Canadian National Dairy Cattle Breeding Project. J. Dairy Sci. 66:867-873.

Walker, A.; Hance, R. J.; Allen, J. G.; Briggs, G. G.; Chen, Y.-L.; Gaynor, J. D.; Hogue, E. J.; Malquori, A.; Moody, K.; Moyer, J. R.; Pestemer, W.; Rahman, A.; Smith, A. E.;

Streibig, J. C.; Torstensson, N. T. L.; Widyanto, L. S.; Zandvoort, R. 1983. EWRS herbicide-soil working group: Collaborative experiment on simazine persistence in soil. Weed Res. 23:373-383.

Whelan, E. D. P.; Atkinson, T. G.; Larson, R. I. 1983. Registraton of LRS-1F193 wheat germplasm (Reg. No. GP 206). Crop Sci. 23:194.

Miscellaneous

Atkinson, T. G.; Hanna, M. R.; Harvey, A. M.; Howard, R. J.; Huang, H. C.; Miska, J. P.; Sheppard, J. W.; Yorston, J. M. 1983. Verticillium wilt of alfalfa. Tech. Bull. Contrib. 1982-8E Revised. Research Branch, Agric. Can.

Dubetz, S. 1983. Ten-year irrigated rotation U. 1911-1980. Tech. Bull. Contrib. 1983-21E. Research Branch, Agric. Can.

Foroud, N.; Hobbs, E. H. 1983. The LETHIRR irrigation scheduling model. Description and operating procedures. LRS Mimeo Report 5. Agriculture Canada Research Station, Lethbridge, Alta.

Grant, M. N. 1983. Winter wheat breeding objectives for Western Canada. Pages 89-101 *in* Fowler, D. B.; Gusta, L. V.; Slinkard, A. E.; Hobin, B. A., eds. New frontiers in winter wheat production. Proceedings Western Canada Winter Wheat Conference. June 20–22, 1983. University of Saskatchewan Printing Services, Saskatoon, Sask.

Hardman, J. M. 1983. A user's guide to RANGE, a computer program simulating grasshopper damage to rangeland. LRS Mimeo Report 4. Agriculture Canada Research Station, Lethbridge, Alta.

Harper, A. M. 1983. Spotted alfalfa aphid. Alberta Agriculture. Agdex 622-17.

Harper, A. M.; Whitfield, G. H. 1983. Beet webworm. Alberta Agriculture. Agdex 622-11.

Harper, A. M.; Whitfield, G. H. 1983. Sugar beet root aphid. Alberta Agriculture. Agdex 622-12.

Harper, A. M.; Whitfield, G. H. 1983. Beet leaf miner. Alberta Agriculture. Agdex 622-13.

Hobbs, E. H.; Krogman, K. K. 1983. Scheduling irrigation to meet crop demands. Tech. Bull. Contrib. 1983-10E. Research Branch, Agric. Can.

Krunic, M. D.; Brajkovic, M. M.; Richards, K. W. 1982. Some aspects of cold-hardiness in *Megachile rotundata* Fabr. (Hymenoptera: Megachilidae). Pages 35-40 *in* Proceedings 1st Int. Symp. Alfalfa Leafcutting Bee Management, 16–18 August 1982. University of Saskatchewan Printing Services, Saskatoon, Sask.

Lilly, C. E. 1983. Lightning damage in field crops. Canadex 100.09.

Looman, J.; Majak, W.; Smoliak, S. 1983. Stock-poisoning plants of Western Canada. Tech. Bull. Contrib. 1982-7E. Research Branch, Agric. Can. 35 pp.

Major, D. J.; Wilson, D. B. 1983. Sorghum production in dryland, short-season conditions. Proc. 37th Annu. Corn Sorghum Ind. Res. Conf. 37:10-25.

Moyer, J. R. 1983. Adsorption and bioavailability of wild oat herbicides and associated effects in efficacy and soil fertility. Pages 133-140 *in* Wild oat symposium: Proceedings Canadian Plains Proceedings 12. Canadian Plains Research Center, Regina, Sask.

Richards, K. W. 1982. Inputs, expectations, and management of the alfalfa leafcutter bee, *Megachile rotundata*. Pages 113-135 *in* Proceedings 1st International Symposium Alfalfa Leafcutting Bee Management, 16–18 August 1982. University of Saskatchewan Printing Services, Saskatoon, Sask.

Roberts, D. W. A. 1983. Metabolism in winter wheat at low temperatures. Pages 77-88 *in* Fowler, D. B.; Gusta, L. V.; Slinkard, A. E.; Hobin, B. A., eds. New frontiers in winter wheat production. Proceedings Western Canada Winter Wheat Conference 20–22 June 1983. University of Saskatchewan Printing Services, Saskatoon, Sask.

Schaber, B. D. 1983. The behaviour of *Odynerus dilectus*, a predator of the alfalfa weevil. Pica 4(3):17-20.

Smoliak, S.; Wilson, D. B. 1983. Forage crops on the prairies. Pages 35-39 *in* Proceedings National Forage Symposium 1981. Research Branch, Agriculture Canada. 197 pp.

Thomas, J. B. 1983. Genetic variation in yield and protein content of winter varieties of winter wheat. *In* Proceedings Wheat Protein Management Workshop, 17–18 February 1983, Winnipeg, Man., Canadian International Grains Institute.

Thomas, J. B.; Gaudet, D. A. 1983. The winter wheat breeding program at Lethbridge: Some ideas and approaches. Pages 208-227 *in* Fowler, D. B.; Gusta, L. V.; Slinkard, A. E.; Hobin, B. A., eds. New frontiers in winter wheat production. Proceedings Western Canada Winter Wheat Conference 20–22 June 1983. University of Saskatchewan Printing Services, Saskatoon, Sask.

Whitfield, G. H.; Harper, A. M. 1982. Sugar beet root maggot. Alberta Agriculture Agdex 622-10.

Whitfield, G. H.; Harper, A. M. 1983. Flea beetles on sugar beets. Alberta Agriculture Agdex 622-14.

Whitfield, G. H.; Harper, A. M. 1983. Wireworms on sugar beets. Alberta Agriculture Agdex 622-15.

Whitfield, G. H.; Harper, A. M. 1983. Miscellaneous insect pests of sugar beets. Alberta Agriculture Agdex 622-16.

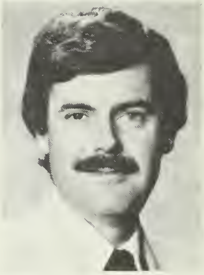
Wilson, D. B. 1983. Recommended forage crop varieties for 1983. Canadex 120.30.

Zentner, R. P.; Lindwall, C. W. 1983. Economics of minimum tillage practices for summer fallow preparation in southern Alberta. Can. Agric. 1:22-25.

PACIFIC REGION
RÉGION DU PACIFIQUE

Dr. W. Baier

Dr. H. R. Davidson



Mr. H. A. Reid

EXECUTIVE OF THE PACIFIC REGION
L'EXÉCUTIF DE LA RÉGION DU PACIFIQUE

Acting Director General
Directeur général intérimaire

W. Baier, Diplomlandwirt, Dr.Agr., M.S.

Program Specialist
Spécialiste en programmes

H. R. Davidson, B.Sc., Ph.D.

Chief, Administration
Chef, administration

H. A. Reid

PREFACE

The Pacific Region of the Research Branch, with Headquarters in the Vancouver area, was created in August 1983 by splitting the former Western Region, which comprised the four most western provinces, into the Pacific and Prairie regions. The Pacific Region comprises the five major Research Stations in British Columbia, as well as four experimental farms and substations. The creation of the Pacific Region demonstrates the importance of western agriculture and of the unique climatic and environmental conditions of British Columbia. This organizational change completes the plan which began in 1977 to regionalize decision-making for the Research Branch's activities across Canada.

The activities at each station are designed to make a contribution to the national research programs and to serve the needs of the agricultural industry in that area. In 1983 significant advances were made toward the achievement of all nine Branch objectives and were transferred to the agricultural sector through 90 scientific publications, 135 miscellaneous publications, and one patent.

The Animal Science Section of the Agassiz Research Station conducts research into dairy cattle, with particular emphasis on mineral nutrition and forage utilization; poultry, toward improving the quality of eggs, carcasses, and feed efficiency; and rabbits, featuring the only rabbit colony in Agriculture Canada, used for management studies in an effort to obtain the same production efficiencies for the rabbit industry as have been obtained for the poultry industry. The Crop Science Section studies the problems of soil fertility, herbicides, soil and water management, and crop management for corn silage, forage production, berries, vegetables, and turf. Vegetable-storage research complements the intensive program on season extension, including overwintering.

The Kamloops Research Station and its affiliate, the Prince George Experimental Farm, serve the interior dry belt beef-ranching industry and crop production areas, conducting research in a diversity of climatic and ecological zones spanning highly productive irrigated valley bottoms to alpine regions. Programs include ecology and range management, studies on toxic plants, reseeding and management of grasslands and clearcut forested areas, species evaluation and management, soil fertility, and nutrient deficiencies of both plants and animals. The station is a recognized center of excellence in the Pacific Northwest for research on intermontane rangelands and integrated resource management for cattle, trees, and wildlife.

The Saanichton Research and Plant Quarantine Station, on the southern tip of Vancouver Island, has a dual responsibility. It is the research center for greenhouse ornamentals and vegetables in British Columbia and is responsible for the national post-entry plant quarantine program in Canada. Close cooperation is maintained with the Food Products and Inspection (FPI) Branch, which provides partial funding in support of the post-entry quarantine program. Its research programs emphasize nutritional and physiological problems in floriculture, plant propagation, postrooting development of nursery plants, eradication of viruses, rapid multiplication of grapes and ornamentals by tissue culture, and control of pests and diseases in vegetables and ornamentals. The Station is also responsible for research in energy conservation utilizing solar energy, thermal blankets, and a computerized greenhouse climate control system.

Research done at the Summerland Research Station serves the fruit growing, packing, and processing industry located in the south central portion of the Okanagan Valley. Tree fruits and grapes are grown on the light silty clay soils of the Benchlands, primarily under irrigation. The Station program has been highlighted by the development of the sterile codling moth technique for biological control of one of the most severe orchard insect pests. Excellent rapport with the fruit industry has enabled the Station to assist in evaluating new disease-free varieties for the grape and wine industry, and in developing improved fruit storage, new processing techniques, and several new food products from tree fruits, grapes, and their byproducts.

The Vancouver Research Station, on the campus of the University of British Columbia, is close to the most intensive vegetable and small-fruit production in the province. This Station is the national center for plant virus research, with a program spanning basic research on plant viruses and their infected hosts to the application of that research for solution of field problems. It also serves the coastal areas and the interior of the province on problems of insect pests and diseases of various crops. An intensive program of biotechnology is also carried out, aimed primarily at diagnosis of viral, bacterial, and other diseases of small fruit, vegetables, and fruit trees.

A national contracting-out program complementing the regional research effort encourages all sectors of the agri-food industry in the province to participate in finding solutions to the technological problems facing agricultural production.

Further information can be obtained directly from the relevant research station or by contacting Pacific Region Headquarters at 750 Cambie Street, Vancouver, B.C. V6B 4T5.

W. Baier

PRÉFACE

La Région du Pacifique de la Direction générale de la recherche a été formée en août 1983 à même l'ex-Région de l'Ouest, qui comprenait les quatre provinces les plus occidentales et a été divisée en Région du Pacifique et Région des Prairies. Elle comprend les cinq principales stations de recherches de la Colombie-Britannique, soit Agassiz, Kamloops, Saanichton, Summerland et Vancouver ainsi que quatre fermes expérimentales et sous-stations. La création d'une Région du Pacifique témoigne de l'importance qu'attache Agriculture Canada à l'agriculture de l'Ouest et en particulier de la Colombie-Britannique dont les conditions climatiques et l'environnement lui confèrent un caractère particulier. Ce changement administratif complète le projet, amorcé en 1977, visant à régionaliser les activités de la Direction générale de la recherche et les décisions à prendre en fonction de chacune des régions.

Les activités de chacune des stations ont pour but d'apporter leur contribution aux programmes nationaux de recherches et de répondre aux besoins de l'agro-industrie de la région concernée. En 1983, des résultats significatifs ont été obtenus dans la réalisation de neuf objectifs qui ont été communiqués au secteur agricole dans 90 publications scientifiques et 135 publications diverses et par un brevet.

La section de la science zootechnique de la station de recherches d'Agassiz effectue des recherches sur le bétail laitier, les minéraux alimentaires et l'utilisation des fourrages, sur la volaille (qualité des oeufs, des carcasses et efficacité de l'alimentation), sur les lapins (la seule colonie de lapins d'Agriculture Canada sert à des expériences touchant les techniques d'élevage qui ont pour but de créer chez cette espèce une augmentation de productivité pareille à celle qu'on a obtenu chez la volaille). La Section des plantes cultivées recueille des informations relatives à la fertilité des terres, aux herbicides, à la protection du sol et de l'eau. Elle étudie les problèmes de production des récoltes: maïs d'ensilage, plantes fourragères, petits fruits, légumes et gazon. Des recherches concernant l'entreposage des légumes vont de pair avec le programme intensif visant à prolonger la saison de production et la survie à l'hiver des cultures en terre.

La station de recherches de Kamloops et sa filiale, la ferme expérimentale de Prince George, s'intéressent particulièrement à la production du boeuf de boucherie dans les pâturages de la zone sèche de la région intérieure, et aussi aux régions de cultures, en effectuant des recherches dans des zones climatiques et écologiques très diverses allant des vallées irriguées à hauts rendements jusqu'aux régions alpestres. Les programmes comprennent l'écologie et la culture des pâturages et portent sur les plantes toxiques, le réensemencement et l'aménagement des pâturages naturels et des terres forestières après une coupe à blanc; l'appréciation et la culture de différentes espèces; la fertilité des sols et les carences en éléments nutritifs des plantes et des animaux. La station est reconnue dans le nord-ouest de la région du Pacifique pour ses recherches sur les pâturages naturels entre montagnes et sur la gestion globale de ressources aussi variées que les bestiaux, les arbres, et la faune sauvage.

La station de recherches et de quarantaine des plantes de Saanichton qui est située à l'extrémité sud de l'île de Vancouver a une double fonction. Elle sert de centre de recherches sur les plantes ornementales de serre et sur les cultures maraîchères en Colombie-Britannique, et est chargée aussi d'appliquer les prescriptions relatives à la quarantaine des végétaux qui entrent au Canada. Cette dernière fonction implique une étroite coopération avec la Direction générale de la production et de l'inspection des aliments qui assume une partie du financement de ses activités. On accorde beaucoup d'attention aux aspects de la floriculture touchant la fertilisation et la physiologie, la propagation des plants, le développement des plants de pépinière après transplantation, l'élimination des virus, la multiplication rapide des raisins et des plantes ornementales par cultures de tissus, ainsi qu'à la lutte contre les insectes et les maladies des légumes et des plantes ornementales. La station contribue également aux recherches sur la conservation de l'énergie en étudiant les possibilités de l'énergie solaire, les couvertures thermiques et le contrôle informatisé du climat dans les serres.

Les travaux de recherches de la station de Summerland servent surtout aux industries de culture, de conservation et de transformation des fruits de la région sud-centrale de la vallée de l'Okanagan. Les arbres à fruits et les vignes y sont cultivés dans les sols légers limono-argileux des Benchlands, le plus souvent avec irrigation. Le programme de la station est caractérisé surtout par le développement de la stérilisation de la pyrale du pommier comme instrument biologique de lutte contre l'un des insectes les plus nuisibles aux vergers. La station entretient d'excellents rapports avec l'industrie des fruits et a pu apporter un concours appréciable à l'industrie du vin en faisant l'évaluation de nouvelles variétés de raisins; elle a amélioré l'entreposage des fruits, présenté de nouvelles techniques de transformation et développé plusieurs produits alimentaires nouveaux à partir des gros fruits, des raisins et de leurs dérivés.

La station de recherches de Vancouver se trouve sur le campus de l'Université de la Colombie-Britannique, à proximité des centres les plus importants de production de légumes et de petits fruits de la province. La station est le centre national de recherches sur les virus affectant les végétaux, et son programme embrasse la recherche de base sur ces virus et sur les hôtes qui les véhiculent afin de résoudre les problèmes existants. Elle aide les régions côtières et celles de l'intérieur de la province à combattre les insectes et les maladies qui s'attaquent aux cultures les plus diverses. On poursuit également un programme biotechnique intensif visant surtout le diagnostic des maladies d'origine virale, bactérienne ou autre chez les petits fruits, les légumes et les fruits de vergers.

Un programme national de contrats extérieurs servant de complément aux efforts de recherches régionaux encourage tous les secteurs agro-alimentaires de la province à chercher des solutions aux problèmes technologiques de la production agricole.

Les personnes intéressées à recevoir de plus amples renseignements peuvent s'adresser directement aux stations concernées ou en communiquant avec le siège de la Région du Pacifique, 750 Cambie Street, Vancouver (C.-B.) V6B 4T5.

W. Baier

Research Station

Agassiz, British Columbia

PROFESSIONAL STAFF

J. E. Miltimore, B.S.A., M.Sc., Ph.D.	Director
D. H. Frey, B.Sc.	Analyst Programmer
J. Repstock	Administrative Officer
M. C. Vidal,[1] B.A., M.L.S.	Librarian

Animal Science

L. J. Fisher,[2] B.S.A., M.Sc., Ph.D.	Head of Section; Dairy cattle nutrition
W. T. Buckley, B.Sc., Ph.D.	Ruminant mineral biochemistry
R. J. Forrest, B.S.A., M.S.A., Ph.D.	Animal physiology, meat studies
E. E. Gardiner, B.Sc., M.Sc., Ph.D.	Poultry nutrition
J. R. Hunt, B.S.A., Ph.D.	Poultry physiology

Crop Science

J. A. Freeman, B.S.A., M.S.A., Ph.D.	Head of Section; Physiology of small fruits, herbicides
S. G. Fushtey, B.Sc., M.Sc., Ph.D.	Turf management, cereals
J. C. W. Keng, B.Sc., M.Sc., Ph.D.	Crop and soil management
C. G. Kowalenko,[3] B.S.A., M.Sc., Ph.D.	Soil biochemistry and fertility
A. R. Maurer, B.S.A., M.Sc.	Physiology of vegetable crops
P. W. Perrin, B.Sc., Ph.D.	Postharvest physiology

VISITING SCIENTIST

R. C. Newberry, B.Sc., Ph.D. National Research Council of Canada visiting fellow, 1983–1984	Poultry behavior

---

[1] Seconded from Libraries Division, Finance and Administration Branch.
[2] On transfer of work to University of California, Davis, CA, from January to 15 August 1983.
[3] On a Canadian International Development Agency (CIDA) assignment to Sri Lanka, from January to 1 August 1983.

INTRODUCTION

Research at Agassiz is directed at solving problems for a wide variety of commodities. Dairy cattle nutrition and management research, with particular emphasis on mineral nutrition and utilization of hay and grain silages, applies beyond the immediate dairying region in south coastal British Columbia. Results of studies on improving feed efficiency for laying hens and broilers as well as on water consumption and behavior are used internationally. A small rabbit colony provides data for an important fledgling Canadian rabbit industry.

Crops research tends to be more applicable to British Columbia. Corn silage, forage, berries, vegetables, filberts, and turf are the most important commodities served. Herbicides, soil fertility, soil and water management, forage crops management, and vegetable storage management–physiology are the principal disciplines.

This report refers to some of the major research achievements in 1983. A highlight in poultry concerned the effect of differing behavior of individual birds, which invalidated results of tests in which a commercial perch was used. Milk yield of first-lactation heifers was increased proportionately more by larger size than by age at calving.

Fertilizer requirements of filberts were more accurately predicted by analyses of leaves than by soil tests. Overwintered cauliflower produced the best heads and had the greatest frost tolerance when seeded in mid July and transplanted a month later. Conditions for satisfactory use of terbacil on dormant transplanted raspberry canes were determined.

Additional details concerning the research program and results achieved may be obtained by requesting copies of the listed publications and other informal reports. Requests should be directed to the Research Station, Agriculture Canada, P.O. Box 1000, Agassiz, B.C. V0M 1A0.

J. E. Miltimore
Director

ANIMAL SCIENCE

Planting density and nutritive value of corn silage

A late maturing corn hybrid was planted at 60 000 and at 100 000 plants per hectare. At harvest the dry matter was 24.2 and 22.8%, and the ear content was 34 and 28% for the low- and high-density plantings, respectively. Two groups of 10 lactating cows were used to compare the nutritive value of the ensiled corn over a 10-wk feeding period. Feeding the low-density silage resulted in a decreased level of acetic acid in the rumen and an increased level of propionate corresponding to a lower milk-fat test for cows fed the silage with the higher proportion of grain. A 6% increase in ear content resulted in a corn silage that, when fed, produced an increase in dry-matter intake and milk yield but a decrease in milk-fat content.

Weight and age at calving on initial milk yield

Daily milk yields from 400 first lactations were utilized to ascertain the effect of weight and age at calving, as well as change of body weight during first lactation, on milk yield and calving interval. Both year and season of calving influenced weight at calving, milk yield, and the relationship between the two. Calving weight but not calving age accounted for a significant portion of variation for the first four 60-day periods of the lactation, and both age and weight at calving significantly influenced total milk yield. There was an increase in number of services and a trend toward a longer calving interval (12 days), with each 100 kg in first-lactation milk yield.

Buffering corn silage

A series of trials with lactating cows fed corn silage as the only forage was carried out to determine if sodium bicarbonate or bentonite added to corn silage just prior to feeding improved dry-matter intake and digestibility. Cows fed silage supplemented with bentonite had lower milk-fat and protein percentages and rumen pH compared with those supplemented with sodium bicarbonate. It was concluded that bentonite as fed in these experiments did not act as a buffer, and although sodium bicarbonate improved milk yield and milk-fat content, its effect was not consistent and its use as a supplement of corn silage was not profitable.

Behavior of roaster chickens during automatic weighing

Automatic weighing equipment developed by the National Institute for Agricultural Engineering, Silsoe, England, was tested on a flock of roaster chickens. In the 10-wk trial, the mean body weights obtained with this equipment were lower than those obtained by manual weighing. Certain birds were observed to step onto the strain-gauged weighing perch more frequently than would be expected if flock members perched at random, and this provided a possible source of bias. Results may also have been skewed towards the lower end of the weight range because of the inability of the machine to distinguish between birds mounted fully on the perching platform and birds lying on the perch with their feathers touching the floor, which frequently occurred from the age of 6 wk on.

Water consumption of meat-type chickens

The water consumption of meat-type chickens was measured daily from zero to 9 wk of age. Water consumption in litres per 1000 chicks increased from 226.4 L in wk 1 to 2353.7 in wk 9. The water-to-feed ratios ranged from 1.34 to 2.06 and varied considerably from previously published values. This observation questions recommendations for the addition of medicants to water that assume a constant water-to-feed ratio.

CROP SCIENCE

Nematicide application by trickle irrigation

Two nematicides, Nemacure and Furadan, were applied to a nematode-infested sandy loam soil in a 7-yr-old raspberry field by a portable trickle irrigation system. Control of the zone of application was accurate to within + 10% with the use of a physical model that was specifically developed for the irrigation system. Significant reductions in the number of nematodes were recorded in the 1st yr. This system will reduce cost of nematode control by increased nematicide effectiveness, compared with the currently recommended fumigation method. Soil compaction would be minimized as traffic over the field could be controlled and reduced to a minimum, and the soil surface between rows would be kept drier than on the row. Fertilizer application could be incorporated with the trickle system as well.

Dimethyl sulfoxide (DMSO) for soil structure protection during freezing

In study of soil structure, samples are examined visually after they have been impregnated with plastic. The soil must be dried for proper impregnation. However, drying by heating or freezing is known to change the natural structure because of shrinkage or ice-crystal formation. Dimethyl sulfoxide was studied as an agent for reducing changes, associated with sample preparation during freeze-drying, in the structure of pores.

Undisturbed heavy clay soil cores (75 mm high and 75 mm in diameter) were saturated with 0, 1, 28, and 35% DMSO water solution before freeze-drying. Shrinkage measurements suggested that the shape of soil samples has the most effect on directional shrinkage. Mercury intrusion data and scanning electron microscopy (SEM) photographs indicate the DMSO treatments altered the pore size distributions but preserved soil pores in the size range of 100 nm, the pores that are most important in water and nutrient storage.

The results of the experiment lead to the interesting find that for this particular soil, the pores in the range of 10–100 nm seem most susceptible to compaction caused by ice-crystal formation.

Vitamin C losses during frozen storage of cole crops

Broccoli, cabbage, and cauliflower were preconditioned at 20, 10, and 0.5°C for 24 h prior to freezing or blanching and freezing. Vitamin C loss was greatest in broccoli (25%) and least in cabbage (1%) after holding for 24 h. Storage at 0.5°C prior to freezing minimized the initial losses caused by freezing without blanching. However, after 9 days at –20°C, the vitamin C loss was the same for all preconditioning temperatures. Blanching resulted in immediate loss of Vitamin C in all vegetables, but this loss did not increase during subsequent freezing and storage at –20°C for 9 days. Vitamin C losses from blanching or freezing were greatest for broccoli (77%) and least for cauliflower (48%).

Overwintered cauliflower

In a series of trials conducted over four winter seasons at Agassiz and Abbotsford, cultivars of winter cauliflower best suited to the British Columbia coastal climate were selected. Dates of seeding were found to be critical in both severe and mild winters. Optimum yields resulted from mid July seeding, followed by early July seeding. Early August seeding resulted in smaller heads and lower yield. Plant survival was affected by seeding date in severe winters, the earlier seedings being more susceptible to winter injury than the later, but in mild winters all seeding dates had close to 100% plant survival.

Predicting fertilizer requirements of filberts

Optimum concentrations of Ca, Mg, S, Cu, and Zn in filbert leaves were derived from consistent correlations among nutrients with the use of survey research data of 17 orchards over a 3-yr period (1978–1980) and from critical N and K concentrations reported in the literature. Furthermore, the pubescent (hairy) nature of filbert leaves was shown to enhance the possibility of macro- and micronutrient contamination. The optimum concentrations in leaves can be used as a guide for fertilizer applications of N, P, K, Ca, Mg, S, Cu, and Zn but careful washing of the leaf samples is required.

Correlations among concentrations of nutrients in leaves and soil were observed but were not consistent over the 2 yr of the comparison. Consequently, soil samples were of supplementary rather than primary usefulness for fertilizer predictions for filberts.

Use of terbacil for weed control in newly planted raspberries

Terbacil was tested at 1.0 and 2.0 kg/ha as a postplanting treatment for newly planted raspberries, cultivar Willamette. Terbacil at both rates gave excellent control of broadleaved weeds and grass when common groundsel and pineappleweed infestation was low. Both weeds have shown considerable tolerance for terbacil. The number of raspberry sucker plants was reduced by as much as 50% by terbacil at the rate of 2 kg/ha when root cuttings were used for propagation. However, there was little effect on sucker emergence when dormant canes were used. It is thought that the injury from terbacil to suckers from root cuttings is probably a result of the fact that sucker plants emerge earlier than those from dormant canes. The injury to primocanes (suckers) from root cuttings was reflected in decreased growth and yield reduction. When dormant canes were used, growth and yield were not affected.

Stale seedbed treatments for weed control in cucumbers

The herbicides HOE 39866 at 1.0, 1.5, and 2.0 kg/ha; glyphosate at 0.5, 1.0, and 2.0 kg/ha; and SC-0224 at 1.0, 1.5, and 2.0 kg/ha were tested as stale seedbed treatments for weed control in cucumbers, cultivar Wisconsin MR 18 pickling. The seedbed was prepared to stimulate weed growth. When the weeds emerged, the cucumbers were seeded without further cultivation. The herbicides were applied at least 3 days prior to emergence of the crop. Weed seedlings present at the time of spraying included lady's-thumb, common chickweed, shepherd's purse, lamb's-quarters, common groundsel, low cudweed, corn spurry, and barnyard grass.

All treatments resulted in good to excellent control of broadleaved weeds and barnyard grass, with no detrimental effect on the crop.

PUBLICATIONS

Research

Fisher, L. J. 1983. Evaluation of concentrated whey and canola meal mixture as a substitute for grain in the rations of calves. Can. J. Anim. Sci. 63:587-593.

Fisher, L. J.; Fairey, N. A. 1982. The effect of planting on the nutritive value of corn silage for lactating cows. Can. J. Anim. Sci. 62:1143-1148.

Fisher, L. J.; Hall, J. W.; Jones, S. E. 1983. Weight and age at calving and weight change related to first lactation milk yield. J. Dairy Sci. 66:2167-2172.

Fisher, L. J.; MacKay, V. G. 1983. The effect of sodium bicarbonate, sodium bicarbonate plus magnesium oxide or bentonite on the intake of corn silage by lactating cows. Can. J. Anim. Sci. 63:141-148.

Fisher, L. J.; MacKay, V. G. 1983. The investigation of sodium bicarbonate or bentonite as supplements in silages fed to lactating cows. Can. J. Anim. Sci. 63:939-947.

Fisher, L. J.; Van Merle, F. 1983. The effect of level and frequency of feeding whole milk on body weight gain and feed conversions of calves. Can. J. Anim. Sci. 63:473-476.

Forrest, R. J. 1982. A comparison of the growth and carcass characteristics of steers reared on pasture and finished for varying periods on corn or grass silage. Can. J. Anim. Sci. 62:1079-1088.

Freeman, J. A. 1983. The response of sweet corn cultivars to combinations of thiocarbamate herbicides and the insecticide fonofos. Acta Hortic. 136:29-34.

Keng, J. C. W.; Topp, G. C. 1983. Measuring water content of soil columns in the laboratory: A comparison of gamma-ray attenuation and TDR techniques. Can. J. Soil Sci. 63:(1)37-43.

Miscellaneous

Fisher, L. J. 1983. The function of buffers in ruminant diets. Proceedings 18th Pacific Northwest Animal Nutrition Conference, Corvallis, OR, pp. 61-68.

Fisher, L. J.; Buckley, K. E. 1983. Whey as a feedstuff for ruminants. Proceedings 18th Pacific Northwest Animal Nutrition Conference, Corvallis, OR, pp. 83-88.

Fisher, L. J.; Buckley, W. T. 1983. Whey as a feedstuff. Can. Agric. 29:46-47.

Freeman, J. A.; Pepin, H. S. 1983. Strawberry and raspberry fruit rot control in B.C. Can. Agric. 2:26-29.

Fushtey, S. G. 1983. Disease reaction of Kentucky bluegrass cultivars licensed for sale in Canada, 1982. Canadex 273.636.

Fushtey, S. G. 1983. Integrated pest management for turfgrass. Proceedings 37th Northwest Turfgrass Conference, Warm Springs, OR, pp. 14-24.

Fushtey, S. G.; Denby, L. G.; McLean, A. 1982. Lawns for southern British Columbia. Agric. Can. Tech. Bull. 19 pp.

Maurer, A. R. 1983. Report of vegetable trials conducted in double-poly tunnels in 1982. Agric. Can., Agassiz Res. Stn. Tech. Rep. 12. 23 pp.

Maurer, A. R. 1983. Winter production of cauliflower. Canadex 252.24.

Maurer, A. R. 1983. Year round lettuce production—1983. Agric. Can., Agassiz Res. Stn. Tech. Rep. 13. 16 pp.

Ormrod, D. J.; Fushtey, S. G. 1983. Diseases of lawns. B.C. Min. Agric. Food Publ. 12 pp.

Perrin, P. W. 1983. Comparison of three high humidity systems for vegetable storage. Proceedings 16th International Congress of Refrigeration, Paris, pp.(D1)196-199.

Perrin, P. W. 1983. Influence of preconditioning temperatures on loss of Vitamin C in cole crops during freezing. Proceedings 16th International Congress of Refrigeration, Paris, pp.(C2)64-68.

Research Station

Kamloops, British Columbia

PROFESSIONAL STAFF

J. D. McElgunn,[1] B.Sc., M.Sc., Ph.D.	Director
P. A. Bluett, B.S.A.	Administrative Officer
A. McLean, B.S.A., M.Sc., Ph.D., F.A.I.C., F.S.R.M.	Range ecology
W. Majak, B.Sc., M.Sc., Ph.D.	Biochemistry
D. A. Quinton, B.S., Ph.D.	Range management
D. G. Stout,[2] B.S.A., M.Sc., Ph.D.	Plant physiology
A. L. van Ryswyk, B.S.A., M.S.A., Ph.D.	Soil science

Prince George Experimental Farm

W. L. Pringle, B.S.A., M.S.F.	Superintendent; Forage
K. Broersma,[3] B.S.A., M.Sc.	Forage agronomy, soils
L. Rode, B.Sc., M.S., Ph.D.	Animal nutrition

VISITING SCIENTIST

A. Muir, B.Sc., Ph.D.	Plant biochemistry

---

[1] Seconded to CIDA May–June 1983.

[2] On transfer of work, Cornell University, New York, NY to June 1983.

[3] On education leave.

INTRODUCTION

The research programs at the Kamloops Range Research Station and at the Prince George Experimental Farm serve the ranchers and managers of the diverse rangelands of interior British Columbia, which vary from true treeless grasslands to forested range and subalpine and wetland meadows.

The response to the *High Tension–High Tensile Fencing* technical bulletin has been good, with the first 800 copies exhausted within the first 6 mo of printing. This fencing design saves 40–60% of the cost over traditional fencing.

Fall sampling of pinegrass roots and crowns for total nonstructural carbohydrates has been shown as a good indicator of grazing management and stand vigor.

Fall seeding of crested wheatgrass was shown to be superior to spring or summer seedings in the interior dry belt of British Columbia.

The sensitivity of bluebunch wheatgrass to defoliation injury is most severe in late spring, and early removal of cattle to allow regrowth is essential for stand productivity and persistence.

Research on hay trials with timothy and meadow foxtail have shown similar dry-matter (DM) yields, but in grazing trials with steers, timothy outyielded meadow foxtail (500 kg/ha versus 391 kg/ha of liveweight gain). These differences were attributed to lower palatability and lower digestibility of meadow foxtail.

Implanted steers (zeranol) gained faster during the first 70 days on pasture than did the nonimplanted control group (1.48 kg/day versus 1.11 kg/day), but from day 70 to day 115 the daily gains were equal (1.17 kg/day versus 1.09 kg/day).

High-moisture barley (70% DM) was ensiled with and without rolling and with and without urea or ammonia treatment. Urea and ammonia were excellent preservatives as compared with natural fermentation; ammoniated whole barley will serve as an economical alternative to rolled high-moisture barley silage.

As these are merely highlights of completed research, anyone who wishes to have further information is encouraged to contact the Director or the scientists at Agriculture Canada, Research Station, 3015 Ord Road, Kamloops, B.C. V2B 8A9, or the Experimental Farm, R.R. No. 8, R.M.D No. 6, Prince George, B.C. V2N 4M6.

J. D. McElgunn
Director

RANGELAND STUDIES

High tension fencing

A technical bulletin, *High Tension–High Tensile Fencing*, was published. The bulletin incorporates the research on high tension fencing reported in the 1982 report and all available data on high tensile fencing technology. Included are sections on principles and properties of fence components, fence materials, specifications, construction, safety factors, and suppliers of fence materials.

Method of measuring pinegrass food reserves

Herbage removal by clipping affected the percentage of total nonstructural carbohydrates (TNC) but not the percentage of crude protein in pinegrass (*Calamagrostis rubescens* Buckl.) rhizome plus roots and crowns. Rhizome plus root TNC predicted the known effect of herbage removal on stand productivity better than crown TNC did. A larger difference between control TNC and treatment TNC was detected when sampling was done on 25 September compared with 29 August. If stored reserves are to be used as a measure of pinegrass vigor following herbage removal, it is recommended that TNC of rhizome plus roots be measured. To maximize the ability to detect a significant difference, sampling should be done in the fall. The data also reveal that fall storage of TNC requires the presence of leaves that developed in the spring.

Fall seeding of grasses best on grassland ranges

Seeding of grasses and legumes is an important method of restoring depleted rangelands of the British Columbia interior to their original forage productivity. The seeding of grasslands is expensive, and so it is important to seed when one might expect the best chance of success. Because of the rigorous climate of the British Columbia interior, seeding operations have to be carefully timed if success is to be achieved.

Trials at the Research Station have shown that fall was the best time to seed crested wheatgrass (*Agropyron desertorum* (Fisch.) Schult.) in the British Columbia dry belt. With fall seedings, if emergence did not take place in the fall, it did so the following spring; there was very little plant kill over the winter. Among the spring seedings, germination took place if the moisture content of the soil was adequate, usually above 10%. Moisture content of the soil was the most important single factor in determining establishment of seedlings. Late May and June seedings often germinated and died before seedlings became established. Rains in June, July, and August were ineffective in promoting emergence but they may have been a factor in ensuring the establishment of the early spring seedlings. Eight years after seeding, fall seedings no longer retained their advantage, but the poor performance of the June seedings was still evident.

Bluebunch wheatgrass management

Bluebunch wheatgrass (*Agropyron spicatum*), an important native forage plant of British Columbia's grassland ranges, is sensitive to grazing injury. Clipping trials were conducted to determine when bluebunch wheatgrass was most and least vulnerable to defoliation injury. Bluebunch wheatgrass mortality was greatest and vigor of surviving plants was lowest on plants clipped to 5 cm at weekly intervals through the growing season, but all clipping treatments involving defoliation from mid April to the end of May resulted in severe injury. Clipping through this period, which coincided with the late-boot stage of bluebunch wheatgrass development and continued past the cessation of leaf growth, removed photosynthetic material at a time when the grasses were building up carbohydrate reserves in roots and stem bases. Inadequate opportunity was allowed for growth of new foliage before the summer dormancy.

Despite some yearly and locational differences, this study illustrates wheatgrass susceptibility to defoliation injury, in particular during late spring. The grass must be given enough time to replenish carbohydrate reserves before summer dormancy. This can be achieved by early removal of cattle to allow for regrowth. Repeated heavy grazing on selected individual plants, as commonly occurs, will eliminate them from the stand.

Grazing timothy and meadow foxtail

A grazing trial carried out at Prince George on a heavy clay soil showed the superiority of timothy (*Phleum pratense* L. 'Climax') over meadow foxtail (*Alopecurus pratensis* L.). Meadow foxtail is a relatively new bunchgrass that resembles timothy but is ready for grazing much earlier in the spring. It has shown good potential for pasture use by plot work and quality measurements.

A 3-yr study in which yearling steers were used has shown that meadow foxtail has a greater carrying capacity than timothy. In spite of this, timothy produced more beef than did meadow foxtail. Timothy averaged 443 steer-days per hectare, the average daily gain was 1.13 kg, and the beef yield was 500 kg/ha. Meadow foxtail averaged 501 steer-days per hectare, the average daily gain was 0.79 kg, and the beef yield was 391 kg/ha.

Great differences occurred between years in total gains primarily because of summer precipitation patterns. For the two grasses, gains averaged 527, 434, and 373 kg/ha for summer precipitation of 202, 298, and 335 mm for 1981, 1982, and 1983, respectively. The higher rainfall was accompanied by cooler temperatures, and grass yields were reduced.

Meadow foxtail appears to have lower palatability than timothy, and hence intake is lower. DM digestibility as measured in grazing steers in 1983 averaged 69.9% for timothy and 65.6% for meadow foxtail. These two factors are the reason for lower animal productivity for steers grazing meadow foxtail. Because meadow foxtail shows good early growth potential it will be tested in rotation with timothy.

Zeranol implantation on pasture

Performance of 30 steers with and without zeranol implantation on a native grass–clover pasture was measured. During the first 70 days, the cattle implanted with zeranol gained 33% more than those without implantation (1.48 kg/day versus 1.11 kg/day). From day 70 to day 115, the two groups of cattle had similar gains (1.17 kg/day versus 1.09 kg/day); thus the advantage of zeranol implantation occurred during the first 70 days and was maintained during the rest of the trial.

Preservatives for high-moisture barley

Urea and anhydrous ammonia were evaluated as preservatives for high-moisture barley (*Hordeum vulgare* L.). Grain (70% of DM) was ensiled as rolled, whole, whole plus urea (6% of DM), or whole plus ammonia (3% of DM). After 6 wk, grains were fed with timothy hay (1:1) to fistulated steers.

Samples of each treatment were placed in nylon bags and incubated in the rumen of steers fed the same treatment. Digestion after 36 h for whole, urea treated, ammonia treated, and rolled barley was 14.4%, 33.0%, 49.2%, and 53.1%, respectively. Urea and ammonia were excellent preservatives for high-moisture barley, being superior to natural fermentation in either whole or rolled barley. Ammoniated whole barley may serve as an economical alternative to rolled high-moisture barley.

Timber milk-vetch (*Astragalus miser* Dougl. ex Hook.) poisoning

The metabolism of intravenously administered 3-nitropropanol (miserotoxin aglycone) was examined in cattle and sheep using high-performance liquid chromatography (HPLC) to determine nitrocompounds in plasma. 3-Nitropropanol (NPOH) showed a rapid rate of decay, and simultaneously, 3-nitropropionic acid (NPA) was detected at comparable levels in plasma. In animals dosed with NPOH, the observed NPA decayed at a slower rate than NPOH. Nitrite levels in plasma were more closely related to NPA than to NPOH. Therefore, metabolism of NPOH is linked to NPA, and this could provide a common basis for the toxicity of these compounds in cattle and sheep.

Bloat of cattle

Rumen contents from the dorsal sac were examined before alfalfa ingestion to determine factors that predispose cattle to pasture bloat. Chlorophyll concentration, buoyancy of particulate matter, and rates of gas production were significantly higher in cattle that subsequently bloated than in those that did not. Higher chlorophyll in bloat cases indicated accumulation of suspended chloroplast particles in the dorsal sac, which perhaps result from increased buoyancy of the particulate matter. The higher fermentation rates (in the presence of glucose) suggested that the latent capacity for gas production was due to microbial colonization of suspended feed particles. Chlorophyll 4 h after feeding was also higher in bloated animals as compared with unbloated ones. In short, the microbial colonization and retention of particulate matter provided active inocula for promoting rapid legume digestion. Consequently, gas production was enhanced when feeding commenced, but the fermentation gases were trapped by the buoyant, frothy ingesta, resulting in the condition of pasture bloat.

Knapweed allelopathy

A survey was conducted in vitro to determine the allelopathic potential of diffuse knapweed (*Centaurea diffusa* Lam.), a noxious weed invading the Pacific Northwest. Knapweed extracts were prepared with the use of various solvents, and inhibitory activity was bioassayed by measuring ryegrass seed germination and seedling growth. Inhibitory activity was found mainly in chloroform- and water-soluble extracts of knapweed. The impact of the latter was not due to osmotic effects as shown by osmolarity measurements or total cation concentration. When the chloroform extract of shoots was purified by column chromatography, inhibition was associated with fractions containing sesquiterpene lactones. Inhibitor levels were lower in knapweed roots than in shoots. In addition to different solubilities, the polar and nonpolar inhibitors showed different elution profiles on Sephadex G-10.

Crested wheatgrass fertilization

Fertilizer trials have not been conducted on crested wheatgrass (*Agropyron desertorum*) even though it is the recommended species for reseeding depleted grassland ranges in British Columbia. Crested wheatgrass that had been established on three Chernozemic (Mollisol) soil sites was fertilized in November 1972 with urea at N rates of 0, 25, 50, and 100 kg/ha. The elevation at these sites was 400, 700, and 900 m. September to August precipitation was estimated at 249, 277, and 307 mm respectively. Forage was harvested at the seed-set to seed-shed stage. DM yields for the control (N at a rate of 0 kg/ha) averaged 280, 440, and 600 kg/ha for the first 4 yr on the three sites. Response to N fertilization was generally related to moisture regime of the site. Average yields were increased to a maximum of 50% over the control for the N rate of 50 kg/ha at the drier site and to a maximum of 86 and 126% over the control for the N rate of 100 kg/ha at the other two sites. In general, DM yields increased and forage N and P concentrations decreased with increased precipitation. Fertilization sometimes increased forage N concentrations but had no significant ($P \leq 0.09$) effect on P, Ca, Mg, or K values. Average efficiency of N uptake increased from the driest (9%) to the wettest (33%) site. The efficiency of N uptake increased from 0% for N at a rate of 25 kg/ha to 41% for N at a rate of 100 kg/ha at the wettest site, but there was no difference at the dry site. Basal areas of plants increased ($P \leq 0.10$) by about 60% when N was used at a rate of 100 and 50 kg/ha on the medium and high precipitation sites, respectively. There was no change in basal area on the drier site.

Freezing and freeze-thaw injury

The influence of thawing on freeze-injured saskatoon (*Amelanchier alnifolia* Nutt.) twigs was evaluated by refreezing freeze-thawed twigs and comparing the HCN release at –5°C from these twigs to the HCN release at –5°C from twigs that had not been thawed. An effect of thawing depended on the physiological state of the twigs, on the degree of freezing stress, or on both. Manifestation of membrane injury does not have an absolute dependence on thawing. Post-thaw temperature influences manifestation of injury, since twigs warmed to 30°C released more HCN than twigs warmed to 1°C when refrozen to –5°C. Although thawing and post-thaw conditions can influence the magnitude of membrane injury, the critical event leading to injury occurs while plants are frozen.

Cattle diets on improved high altitude range

Diets of cattle grazing a seeded area clearcut of lodgepole pine (*Pinus contorta* Dougl.) and Englemann spruce (*Picea engelmannii* Parry) at an elevation of 1300 m were monitored over a 3-yr period. Diets consisted of 57% grasses, 34% forbs, and 9% shrubs. Orchardgrass and timothy were the most important grasses, accounting for 24 and 20% of the diet, respectively. Major forbs in the diet were horsetail (*Equisetum arvense* L.) (9%), lupine (*Lupinus* L. spp.) (9%), and aster (*Aster* L. spp.) (5%). Major shrubs in the diet were willow (*Salix* L. spp.) (4%) and trembling aspen (*Populus tremuloides* Michx.) (2%).

There were no differences between cattle diets for rotation and continuously grazed pastures when diets were evaluated in general. However, there were differences between diets for some individual monthly periods. Of particular interest were the high incidence of horsetail and lupine in period diets. These species, individually, consisted of up to 40% of the total diet from some pastures during August and September. No adverse effects to cattle were noted from consumption of these plants.

PUBLICATIONS

Research

Majak, W.; Howarth, R. E.; Cheng, K.-J.; Hall, J. W. 1983. Rumen conditions that predispose cattle to pasture bloat. J. Dairy Sci. 66:1683-1688.

Majak, W.; Lindquist, S. G.; McDiarmid, R. E. 1983. A simple method for purification and determination of miserotoxin. J. Agric. Food Chem. 31:650-652.

Majak, W.; Pass, M. A.; Madryga, F. J. 1983. Toxicity of miserotoxin and its aglycone (3-nitropropanol) to rats. Toxicol. Lett. 19:171-178.

Stout, D. G. 1983. Evaluation of freezing injury and freeze-thaw injury to membranes of Saskatoon serviceberry twigs by measuring HCN release. Physiol. Plant. 57:573-578.

Stout, D. G.; Suzuki, M.; Brooke, B. 1983. Carbohydrate and protein reserves in pinegrass storage tissues. J. Range Manage. 36:440-443.

Miscellaneous

McLean, A. 1983. Whitmar wheatgrass now licensed for B. C. Canadex. 127.33.

McLean, A.; Wikeem, S. J. 1983. Bluebunch wheatgrass injured by late spring grazing. Canadex. 127.14.

McLean, A.; Wikeem, S. J. 1983. Update on range seeder. Canadex. 742.

Majak, W.; Cheng, K.-J. 1983. Recent studies on ruminal metabolism of 3-nitropropanol in cattle. Toxicon (Suppl.) 3:265-268.

Goplen, B. P.; Howarth, R. E.; Lees, G. L.; Majak, W.; Cheng, K.-J. 1983. Evaluation of selection techniques in breeding for bloat-safe alfalfa. *In* Smith, J. A.; Hays, V. W., eds. Proceedings XIV International Grasslands Congress, Westview Press, Boulder, CO, pp. 221-223.

Green, A. J.; van Ryswyk, A. L. 1982. Chernozems: Their characterization and distribution. Pages 95-111 *in* Grasslands Ecology and Classification Symposium Proceedings. British Columbia Ministry of Forests, Victoria, B.C.

Howarth, R. E.; Cheng, K.-J.; Fay, J. P.; Majak, W.; Lees, G. L.; Goplen, B. P.; Costerton, J. W. 1983. Initial rate of digestion and legume pasture bloat. *In* Smith, J. A.; Hays, V. W., eds. Proceedings XIV International Grasslands Congress, Westview Press, Boulder, CO, pp. 719-722.

Quinton, D. A. 1983 High tension–high tensile fencing. Agric. Can. Res. Branch Tech. Bull. 1983-22E. 57 pp.

Saanichton
Research and Plant Quarantine Station
Sidney, British Columbia

PROFESSIONAL STAFF

Administration

J. M. Molnar, B.S.A., M.Sc., Ph.D.	Director
G. Blair,	Administration Officer

Scientific Support

Watson,[1] B.A., M.Lib.	Librarian

Ornamentals

C. J. French, B.Sc., Ph.D.	Head of Section; Woody ornamentals
W. C. Lin, B.Sc., M.Sc., Ph.D.	Floriculture
J. P. L. Monette, B.Sc., Ph.D.	Tissue culture
A. W. Chiko, B.Sc., M.S., Ph.D.	Viruses

Vegetables

E. M. Van Zinderen Bakker, B.Sc., M.Sc., Ph.D.	Head of Section; Physiology
H. Hartmann, B.Sc. (Agr.), M.Sc., Ph.D.	Plant pathology
D. R. Gillespie, B.Sc., M.Sc., Ph.D.	Entomology
C. Kempler,[2] B.Sc.	Vegetable nutrition

Plant Quarantine

R. C. JOHNSON,[3] B.S.A.	Head of Section; Grape viruses
D. THOMPSON,[3] B.Sc.	Tree fruit viruses

Departure

R. G. ATKINSON, B.S.A., Ph.D.	Plant pathology

---

[1] Seconded from Libraries Division, Finance and Administration Branch.
[2] On educational leave, University of Guelph, until 31 March 1984.
[3] Food Production and Inspection Branch.

INTRODUCTION

The Saanichton Research and Plant Quarantine Station is the ornamentals and greenhouse vegetable research center for British Columbia and is responsible for the national postentry quarantine program. Emphasis is given to research on nutritional and physiological problems in floriculture, plant propagation, postrooting development of nursery plants, eradication of viruses, rapid multiplication of grapes and ornamentals by tissue culture, and control of pests and diseases in vegetables and ornamentals. The Station also conducts research in energy conservation through the use of solar energy, thermal blankets, and a computerized climate-control system. Requests for information or publications should be addressed to the Saanichton Research and Plant Quarantine Station, 8801 East Saanich Road, Sidney, B.C. V8L 1H3.

J. M. Molnar
Director

ORNAMENTALS

Management

Gerbera flowering affected by temperature and light. Productivity of cut-flower *Gerbera* in winter (November–March) was studied. Reducing the normal air temperature of 20 and 16°C (day and night) to 16 and 12°C reduced the flowers per plant by 26%. However, plants grown with supplementary lighting from high pressure sodium (HPS) at low air temperature produced 36% more flowers than controls at normal air temperature. At normal air temperature, HPS resulted in a 65% increase compared with ambient natural daylight. Soil warming to 21°C had little effect on number of flowers, but slightly improved flower quality.

Alstroemeria flowering affected by low soil temperature and high-intensity lighting: A second-year report. Alstroemeria 'Regina' plants flowered more in the 2nd than in the 1st yr. During the 2nd yr (spring–summer, 21 March–20 September), soil cooling to 3°C from 18°C increased flowering from 115 to 253 shoots per square metre with supplementary HPS light and from 160 to 220 without HPS. During the second fall and winter (21 September–20 March), soil cooling to 11°C from 16°C increased flowering from 1 to 170 shoots per sqare metre with HPS and from 2 to 101 shoots per square metre without HPS. Soil cooling overcame the nonflowering habit of Regina during winter.

Effects of high intensity supplementary lighting from HPS lamps on growth of woody ornamentals. Supplementary lighting with HPS lamps for 16 h/day (15 September–15 January) stimulated growth of the following woody ornamentals: *Rhododendron* 'Sonata', *Thuja occidentalis* 'Pyramidalis' and 'Smargd', *Ilex aquifolium* 'Wilsonii' and 'Silver Variegated Standard', and *Camellia japonica* 'Blood of China'. Supplementary lighting from low-intensity incandescent (INC) lamps (8 h at night) was ineffective in promoting growth of Blood of China, Wilsonii, Silver Variegated Standard, and Smargd. INC promoted the growth of Pyramidalis and Sonata but was less effective than HPS. Supplementary lighting consisting of both long day-length and high intensity is required for maximum growth stimulation during fall and early winter.

Effects of CO_2-enriched mist water and supplementary lighting from HPS lamps on rooting of woody ornamentals. CO_2 mist inhibited the rooting of *Camellia japonica* 'Blood of China' and 'Lady Clare' when applied in the fall (14 October–7 January). Rooting was stimulated by CO_2 mist when applied in the spring (8 February–3 May). HPS lighting (16 h/day) had no effect on rooting in either season. Rooting of *Rhododendron* 'Pink Bountiful' was stimulated by CO_2 mist during spring propagation (15 February–15 May), but no effect was found on *Rhododendron* 'Matador', 'Martha Isaacson', and 'Elizabeth'. HPS lighting (16 h/day) had no effect on rooting. CO_2 mist inhibited the rooting of *Clematis* 'Jackmanii' and 'Comtesse de Bouchard' when applied in summer propagation (15 July–30 August).

The effects of CO_2 mist are variable depending on species, cultivar, and season of propagation.

Diseases

Viruses that infect ornamentals. A survey of viruses that infect commercially grown *Hydrangea* species was conducted. Of 73 stocks of various cultivars of *H. macrophylla* sampled, alfalfa mosaic virus, hydrangea ringspot virus (HRSV), or both viruses were detected in 5, 18, and 10 stocks, respectively. HRSV occurred in two of two sampled stocks of *H. acuminata* 'Bluebird' and tobacco ringspot virus was found in two of 23 sampled stocks of *H. paniculata* 'Grandiflora'. There was no evidence of virus infection in 25 stocks of other types of *Hydrangea.*

Cucumber mosaic virus was isolated from variegated *Tolmeia menziesii* and alfalfa mosaic virus (AMV) from *Nandina domestica* 'Nana-purpurea' and *Viburnum opulus.* This is the first report of AMV infecting *Nandina.*

SMALL FRUIT

Management

Kiwi fruit production on Vancouver Island. As reported last year, kiwi fruit production appears very promising on Vancouver Island. Plants planted outdoors 7 yr ago yielded up to 25 kg per plant. The average fruit weighs 110 grams, or about 15 grams more than imported fruit. One cultivar yielded 920 fruits. Although the fruits of this cultivar are not suitable for the fresh market, they are suitable for processing. The six cultivars imported last year from New Zealand and two others from California are well established. The results are very encouraging and indicate the development of a new industry for Vancouver Island.

Diseases

Virus elimination in shoot tips by in vitro heat therapy. In vitro heat therapy (6 h at 39°C followed by 18 h at 22°C for 28 days) eliminated grapevine fanleaf virus from *Vitis vinifera* 'Ranny Vira' as determined by enzyme linked immunosorbent assay (ELISA). Heat therapy was ineffective in eliminating the agent of grapevine leafroll.

Virus elimination by in vitro chemotherapy. A combination of shoot tip culture and in vitro chemotherapy with dihydroxypropyl adenine, vidarabine, or pyrazofuran was ineffective in generating grapevine leafroll-free *V. vinifera* 'Liemberger' shoot tips. However, shoot tips treated with ribavirin produced plants free of symptoms of the grapevine leafroll.

VEGETABLES

Management

Tomatoes in nutrient film technique (NFT). Three varieties of tomato (Rianto, Vendor, and Fiesta) were grown in an NFT system. Rock-wool cubes and a peat–vermiculite mix were compared. Two nutrient solutions were tested. The standard first level of the Saanichton mix for sawdust culture was compared with the recommended English mixture. After 12 wk of harvesting, no statistically significant ($P = 0.05$) difference was found between the two propagating methods or nutrient solutions fed to the plants. There were statistically significant differences ($P = 0.05$) between the cultivars.

Cucumber cultivar trials in an unheated greenhouse. Five seedless cucumber cultivars (Brustar, Brunex, Brudania, Daleva, and Corona) were grown in an unheated plastic Quonset-type greenhouse during the summer. Fruit was harvested from late June to early September. No significant differences ($P = 0.05$) were observed between the number or weight of the Grade 1 fruit. The weight and number of Grade 2 fruit harvested for Daleva were significantly lower ($P = 0.05$) than the other cultivars.

Tipburn in butterhead lettuce cultivars. The incidence of tipburn in lettuce cultivars grown in an NFT system was investigated. Extending the day length with HPS lights during the winter months increased tipburn ratings, and shortening the day length during the summer months decreased the incidence of tipburn.

Diseases

Biological control of powdery mildew and gray mold on greenhouse vegetables. Four hundred isolates of 44 species have been tested both in vitro and in vivo for efficacy as control agents for powdery mildew and gray mold. Fourteen organisms have shown considerable promise. The biology of these potential control agents has been studied in a greenhouse environment. The sensitivity of these organisms to 12 commonly used pesticides has been tested in vitro. The most effective organisms will be tested as part of an integrated pest management system.

Species of whitefly and their parasites in southwestern British Columbia. Four species of whitefly, *Trialeurodes vaporariorum, T. merlini, Aleyrodes spiraeoides,* and *Aleyrodes* n. sp. occur commonly on various host plants. Three common parasite species, *Encarsia formosa* (wild strain), *Euderomophale* sp. and *Amitus* sp., have been reared. *Encarsia formosa* (wild strain) has been established in permanent laboratory culture. All parasite species show promise as cold-adapted parasites of the greenhouse whitefly. In addition, brown lacewings and a midge species were common predators of whitefly eggs and nymphs on native host plants.

Effects of density on oviposition and behavior of Liriomyza trifolii. Densities of two females per sqare centimetre in cages significantly reduced the number of eggs laid per female compared with densities of 0.2, 0.4, and 1 female per centimetre. No concrete evidence for a female-derived oviposition deterrent was found. Observations of females on leaves revealed interactive behavior that appeared to be competitive and territorial. Tests of the hypothesis of random distribution of females on leaves revealed a significant departure from randomness. These results suggest that females may compete for available feeding and oviposition on leaves.

GREENHOUSE ENERGY CONSERVATION STUDIES

Solar energy. The studies tested the performance of two designs for a solar heating system. The first design applies to an east–west-aligned shed-type greenhouse, where the north roof has been replaced by an insulated vertical north wall. A black shade-cloth hanging from a collecting duct mounted along the north ridge acts as a solar collector. A centrifugal fan transfers heated air into two rock storages.

The second design supplies greenhouse heat utilizing an earth thermal storage (ETS) heat exchange system. Surplus daytime heat is stored through a network of buried pipes. We are testing this system in a gable-type glass greenhouse and a double-layered polyethylene Quonset house. The solar shed used 38.8% less energy than a control house during the 9-mo period when 91.1% of the annual heating load occurs. In a commercial operation, this would result in savings of $5.13/m^2 per year, or a payback period of 4.5 yr. In the spring of 1983, the ETS solar greenhouse achieved energy savings of 48.7% compared with the control house. Preliminary results are being used to predict total annual energy savings of 20%. The payback period would be 2.7 yr.

Programmable greenhouse computer. Considerable energy savings have been achieved through the computerization of the Station's new solar greenhouse. The computer control systems coordinate all functions more efficiently than the conventional greenhouse controls. The computer controls seven greenhouse environments (total area 1042 m^2) as well as two nutrient solutions for NFT studies. The computer regulates the modulating hot-water mixing valves, cooling louvers with fan jets, greenhouse vents, and pumps for the NFT systems. Temperature sensors, humidity sensors, conductivity probes, and pH probes are used. Wind vectors and light intensity also influence control.

PLANT QUARANTINE

Plant quarantine section. The volume of plant material submitted for indexing from noncertified sources increased significantly to 130 tree fruit and 44 grape varieties. A large number of tree fruit (67) and grape varieties (10) came from Czechoslovakia, Hungary, Romania, and Bulgaria. Indexing was completed on five apple varieties that will be available for distribution in 2 yr. Our national repository of 575 tree fruit and 274 grape varieties was in heavy demand as 65 645 buds and 130 rootstocks were shipped (a 27% increase over last year).

Rapid woody greenhouse indexing to detect tree fruit viruses. During the winter, trials were undertaken to evaluate controlled-environment indexing techniques. These indicators could be used indoors to cut down the time and expense of field indexing. Five indicators were used for apple viruses, three for pear viruses, and 11 for *Prunus viruses.* Consistent results were achieved in detecting four apple viruses using four indicators, two pear viruses on one indicator, and eight *Prunus* viruses on five indicators. These indicators will be used to replace field indicators.

PUBLICATIONS

Scientific

Chiko, A. W. 1983. *Poinsettia* mosaic virus in British Columbia. Plant Dis. 67:427-428.

Chiko, A. W. 1983. Reciprocal contact transmission of barley stripe mosaic virus between wild oats and barley. Plant Dis. 67:207-208.

French, C. J. 1983. Stimulation of rooting in rhododendrons by increasing natural daylight with low intensity lighting. HortScience 18(1):88-89.

French, C. J.; Hochachka, P. W.; Mommsen, T. P. 1983. Metabolic organization of liver during spawning migration of sockeye salmon. Amer. J. Physiol. 245, R827-830.

Gillespie, D. R.; Beirne, B. P. 1982 (1983). Leafrollers (Lepidoptera) on berry crops in the Lower Fraser Valley, B.C. J. Entomol. Soc. B.C. 769:31-36.

Gillespie, D. R.; Finlayson, T. 1983. Classification of the final-instar larvae of the Ichneumoninae (Hymenoptera: Ichneumonidae). Mem. Entomol. Soc. Can., No. 124. 81 pp.

Gillespie, D. R.; Gillepie, B. I. 1983. A list of plant-feeding Lepidoptera introduced into B.C. J. Entomol. Soc. B.C. 79:37-54.

Hartmann, H.; Sutton, J. C.; Proctor, R. 1983. Effects of atmospheric water potentials, free water and temperature on production and germination of sporangia in *Peronospora parasitica*. Can. J. Plant Pathol. 5:70-74.

Hochachka, P. W.; Mommsen, T. P.; Storey, J.; Storey, K. B.; Johansen, K.; French, C. J. 1983. The relationship between arginine and proline metabolism in cephalopods. Mar. Biol. Lett. 4:1-21.

Lin, W. C.; Molnar, J. M. 1983. *Alstroemeria* 'Alsaan'. Can. J. Plant Sci. 63:565-66.

Lin, W. C.; Molnar, J. M. 1983. Effect of photoperiod and high intensity supplementary lighting on flowering of *Alstroemeria* 'Orchid' and 'Regina'. J. Amer. Hort. Sci. 108(6): 914-917.

Lin, W. C.; Molnar, J. M. 1983. *Rieger elatior* begonia 'Saanred'. Can. J. Plant Sci. 63:563-564.

Mommsen, T. P.; French, C. J.; Emmette, B.; Hochachka, P. W. 1983. The fate of arginine and proline carbon in squid. Pac. Sci. 36(3):343-348.

Mommsen, T. P.; Hochachka, P. W; French, C. J. 1983. The intermediary metabolism of arginine in squid tissue. Can. J. Zool. 61:1835-1846.

Stevenson, J. H.; Monette, P. L. 1983. Delay of onset of leafroll symptom expression in *Vitis vinifera* 'Liemberger' from ribavirin-treated in vitro cultures. Can. J. Plant Sci. 63:557-560.

Miscellaneous

Chiko, A. W. 1983. *Poinsettia* mosaic virus. Canadex 636.286.

Lin, W. C. 1983. Growing gladiolus. Agric. Can. Publ. 1229/E. 20 pp.

Lin, W. C.; Molnar, J. M. 1983. Use of high intensity lighting in greenhouse nurseries. Canadex 275.28.

Research Station
Summerland, British Columbia

PROFESSIONAL STAFF

G. C. Russell, B.S., M.S., Ph.D.	Director
H. F. Madsen, B.A., Ph.D.	Associate Director
L. C. Godfrey, B.Sc.	Head, Administration
K. Neer,[1] B.A., M.L.S.	Librarian

Entomology—Plant Pathology

R. D. McMullen, B.Sc., M.Sc., Ph.D.	Head of Section; Bionomics of pear psylla
N. P. D. Angerilli, B.Sc., Ph.D.	Orchard mite control, San Jose scale
F. L. Banham, B.A.	Stone fruit insects
V. A. Dyck, B.A., M.Sc., Ph.D.	Management of codling moth
A. J. Hansen,[2] Dip.Agr., M.Sc., Ph.D.	Tree fruit virus diseases
H. F. Madsen, B.A., Ph.D.	Apple pest management
W. J. McPhee, B.Sc., M.Sc., Ph.D.	Tree fruit fungus diseases
J. T. Slykhuis, B.S.A., M.Sc., Ph.D.	Stone fruit virus diseases
R. S. Utkhede, B.Sc. (Agr.), M.Sc. (Agr.), Ph.D.	Tree fruit fungus diseases

Food Processing

D. R. MacGregor, B.S.A., M.S., Ph.D.	Head of Section; Product development, microbiology
H. J. T. Beveridge, B.S.A., M.Sc., Ph.D.	Food chemistry and analytical methods
D. B. Cumming, B.S.A., M.Sc., Ph.D.	Food technology
G. E. Strachan, B.S.A., M.Sc.	Enology, food technology

Pomology and Viticulture

E. J. Hogue, B.S.A., M.S., Ph.D.	Head of Section; Herbicides, vegetation management, nutrition
L. G. Denby, B.S.A., M.S.A.	Viticulture, grape breeding
W. D. Lane, B.Sc. (Agr.), M.Sc., Ph.D.	Apple and cherry breeding
N. E. Looney, B.S., M.S., Ph.D.	Pomology, plant physiology, growth regulators
M. Meheriuk, B.Sc., B.Ed., M.Sc., Ph.D.	Fruit storage and biochemistry
H. A. Quamme, B.S.A., M.Sc., Ph.D.	Orchard management, hardiness
A. G. Reynolds, B.Sc. (Agr.), M.Sc., Ph.D.	Grape management

Soil Science and Agricultural Engineering

D. S. Stevenson, B.S.A., M.S., Ph.D.	Head of Section; Soil moisture
A. P. Gaunce, B.Sc., M.Sc., Ph.D.	Pesticide and environmental chemistry
P. B. Hoyt, B.Sc., M.S., Ph.D.	Soil chemistry and management
A. L. Moyls, B.A.Sc., M.S., Ph.D.	Agricultural equipment—development and assessment
G. H. Neilsen, B.Sc., M.Sc., Ph.D.	Soil fertility, plant nutrition
P. Parchomchuk,[3] B.A.Sc., M.S.	Agricultural equipment—development and assessment

VISITING SCIENTIST

O. L. Lau, B.S., M.S., Ph.D. B.C. Tree Fruits Research Associate since July 1976.	Pomology and viticulture

---

[1] Seconded from Libraries Division, Finance and Administration Branch.

[2] On transfer of work to Universidad Polytecnica, E.T.S.I.A., Valencia, Spain, from October 1982 to September 1983.

[3] On educational leave, University of California, Davis, CA, from August 1983 to August 1986.

INTRODUCTION

The Research Station at Summerland is located in the Okanagan Valley in the heart of the main tree fruit and grape production areas of Western Canada. Research is aimed at solving the problems encountered by producers, packers, and processors of tree fruits and grapes and, through this, helping to provide a high-quality product to the consumer. A number of scientific disciplines are brought to bear on research problems including agricultural engineering, biochemistry, enology, entomology, food processing, plant pathology and physiology, plant breeding and nutrition, microbiology, chemistry, and soil physics. Items included in this report indicate the scope and diversity of the program.

Products named in this report are not necessarily recommended for use, nor is there an implication that they have preference over other products that may be used for the same purpose.

Requests for further information or for reprints should be made to individual scientists or to the Research Station, Research Branch, Agriculture Canada, Summerland, B.C. V0H 1Z0.

G. C. Russell
Director

ENTOMOLOGY—PLANT PATHOLOGY

Control of organophosphate-resistant leafrollers

The fruittree leafroller, *Archips argyrospila*, has developed resistance to organophosphate and carbamate insecticides in one of the major apple producing districts of the Okanagan Valley. Laboratory experiments followed by field plots demonstrated that two insecticides, methomyl and methidathion, were effective against the resistant strain if applied to the overwintering eggs just before the eggs hatched. Neither material was toxic to actively feeding larvae, indicating that the resistant mechanism is initiated by feeding and is not present in newly hatched larvae. *Bacillus thuringiensis*, a bacterial insecticide, also provides control, but timing of sprays is critical because the insecticide must be ingested in fairly large amounts to be effective.

Selective pesticides for control of pear psylla

Pear psylla is the most serious pest of pears in British Columbia, and the insect has developed resistance to many of the insecticides recommended for control. A field experiment that compares four spray programs showed that a program based upon pesticides with low toxicity to natural enemies and utilizing mancozeb, *Bacillus thuringiensis*, and SN 72129 (a growth-regulating compound) gave good control by providing a combination of chemical and biological controls. Programs that included materials highly toxic to predators, such as azinphosmethyl, deltamethrin, and permethrin were less effective, based upon fruit injury at harvest.

Fumigation to disinfest codling moth in apples for export

Eggs of codling moth on apples were killed by cold storage at 1°C after 3 wk. When the apples were fumigated with methyl bromide at 36 g/m^3 for 2 h at 10°C, eggs were killed after only 10 days in cold storage. Cold storage alone killed late-instar larvae after 12 wk of storage. If the apples were fumigated with methyl bromide at 13 g/m^3 for 2 h at 10°C, only 30 days of cold storage was needed to obtain 100% mortality. Cold storage killed larvae in cocoons after 16 wk, but mortality was low if the larvae were in diapause. Larvae in diapause were the most difficult stage to kill and required exposure to methyl bromide at 48 g/m^3 for 4 h at 10°C to obtain complete mortality. This high rate and long exposure time causes injury to fumigated apples.

Mass rearing of predaceous mites for integrated control

A new project is under way to develop methods for the mass production and release of carbamate- and pyrethroid-resistant predaceous mites. This program is needed to maintain an effective integrated mite control program that can cope with changing patterns of orchard pesticide use. An organophosphate-carbamate-sulfur-resistant strain of *Typhlodromus occidentalis* was imported from California and released into a greenhouse on pinto beans infested with twospotted mites. After the predaceous mites had become established and had increased in population, they were taken to the field and released into a planting of soybeans, where both prey and predators continued to increase. The soybeans and their mites were then placed in apple trees infested with European red mite. The laboratory pinto beans contained about 7500 predators, which increased to 21 000 on the soybeans. This rearing and release method should lead to an improved itegrated mite program on apples.

Variability in attractiveness of peach twig borer pheromones

A comparison of Zoecon peach twig borer sex pheromone caps purchased in 1981 and 1983 indicated significant variability in degree of attraction of male moths. The pheromone caps purchased in 1981 had been stored at −20°C. Equal numbers of Pherocon IC traps baited with 1981 and 1983 pheromone caps were deployed in five mature peach orchards. The position of the traps was alternated at weekly intervals and the pheromone caps renewed at 6-wk intervals. During a 16-wk period, the 1981 pheromone caps attracted 2.0–5.7 times more male moths than did the 1983 pheromone caps. This degree of difference in attractiveness could result in economic crop loss where number of moths caught per trap, per unit of time, is used as a basis for determining need for control treatments.

Effect of nitrogen fertilizers and compost on the incidence of apple crown rot

There is considerable controversy among scientists as to the effect of N fertilizers on the incidence of root rot diseases. To study this effect in British Columbia apple orchards, a plot was established to compare the effect of ammonium sulfate, ammonium nitrate, calcium nitrate plus urea, two types of compost, steer manure, and sewage sludge on the incidence of crown rot on apple. The tests were run on the susceptible rootstock MM 106, and after the treatments were applied, all trees were artificially inoculated with the crown rot organism *Phytophthora cactorum*. All of the synthetic nitrogen fertilizers and the sewage sludge showed significantly higher crown rot infections compared with the control. There was no significant increase in infection between hardwood compost, softwood compost, steer manure, and the control. These data indicate that crown rot infection in apple trees could be more severe following applications of nitrogen fertilizer.

Monitoring apple powdery mildew in apple orchards

Apple powdery mildew has increased in apple orchards of the Okanagan Valley and has led growers to the belief that current recommendations are no longer effective. The problem is really one of improper timing of fungicides, because there has been no method of predicting the potential for mildew infection. A simple monitoring system that determines the potential for powdery mildew infestation in apple orchards has been developed. The method is based upon winter sampling for primary infections, which are visible as white tips on terminal shoots. A total of 10% of the trees are sampled in an orchard and scored for the presence or absence of mildew. Based upon the percentage of white tips, the following spray schedules are suggested: 0.5%, a pink spray followed by cover sprays as needed; 5–15%, a silver tip spray followed by a pink spray and cover sprays as required; and 15% and over, a silver tip spray followed by a tight cluster spray, a pink spray, and cover sprays as required. The monitoring system identifies problem orchards, provides more efficient distribution of chemicals, and allows for custom-designed spray recommendations over large areas.

Apple replant disease control

In greenhouse tests, the average height of apple seedlings after 14 wk in nontreated portions of 51 soils from sites of old apple trees was 55 mm. The growth was increased by 50% to 500% in 60% of the soils by pasteurization, in 82% of the soils by 11-55-0 fertilizer at 1 μg/L, and in all soils by pasteurization followed by 11-55-0 fertilizer. In experimental trials, the soil at the planting site was disinfected with dazomet, captan, or formalin and fertilized with 100–200 g of ammonium phosphate (11-55-0) before apples were planted where apples, pears, or other fruit trees had previously been grown.

Ribavirin chemotherapy of cherries infected by green ring mottle

Ribavirin, a guanosine analogue, has previously been shown to be effective in preventing the multiplication of apple chlorotic leafspot, a sap-transmissible virus.

In 1980 and 1981, further experiments were conducted to determine whether the compound can also be used to eliminate green ring mottle (GRM), a non-sap-transmissible viruslike agent, from infected trees. Ten systemically infected, 3-yr-old trees were treated with foliar applications of 500 ppm of ribavirin in weekly intervals for periods ranging from 8 to 16 wk. During and after the treatment period, buds were taken from old and newly developed wood and were tested for GRM by indexing.

The results show that even the shortest treatment (8 wk) was sufficient to prevent the replication of the GRM agent in the newly developing wood. Trees treated for 16 wk remained free of GRM for at least 2 yr, the longest period tested. Ribavirin treatment seems to be an effective, fast, and economical chemotherapeutic method that can replace other methods wherever the host is infected with ribavirin-sensitive viruses or viruslike agents.

Canindex 1, a new indicator of little cherry disease

Little cherry disease (LCD), caused by a viruslike agent, is a serious threat to Okanagan orchards. Control depends partly upon rapid and reliable LCD identification followed by removal of infected orchard trees. However, field identification is complicated by the fact that other causes can induce symptoms similar to LCD. To overcome this problem, we have used a test method that consists of placing buds from suspicious field trees onto young trees of the cultivar Sam. This cultivar reacts with prematurely red foliage discoloration late in the fall, if the applied bud contains the little cherry agent.

In order to facilitate earlier recognition of infected orchard trees, a new test cultivar has been developed. It originated from one seedling in a population of 2000 LCD-infected sweet cherry seedlings and it was selected because it showed red leaf discoloration during summer as well as a strikingly darker coloration in fall. Following thermotherapy and clonal propagation, five small trees each of Sam, of the American test cultivar Deacon, and of the new test cultivar were inoculated with LCD and were observed for two growing seasons. The new test cultivar consistently developed earlier and darker leaf coloration than either Sam or Deacon and permitted a better distinction between healthy and infected trees.

The new test cultivar has been named Canindex 1. Further tests in other climatic areas are recommended so that the universal adaptability of Canindex 1 can be determined. Virus-free budwood is available from the Agriculture Canada Research and Plant Quarantine Station, 8801 East Saanich Road, Sidney, B.C. V8L 1H3, or from this Research Station.

FOOD PROCESSING

Long-life survival foods

Formulas have been developed and shelf life studies have been carried out on beef- and biscuit-based survival bars. Bars stored at room temperature in vacuum-packed foil laminate bags have a shelf life of at least 5 yr. The dry materials are prepared with a minimum of added water to provide cohesion, compressed into 25-g bars, dried to below 3% moisture, and vacuum-packed two to a package. The beef bars consist of a base of cooked, ground, freeze-dried lean beef plus hydrogenated vegetable shortening to which are added salt, spices, antioxidants, and optional freeze-dried vegetables. Biscuit bars are based on a cooked mixture of flour and hydrogenated vegetable shortening with added ingredients such as chocolate, cheese, dried fruits, and flavorings. Bars based on fruit have been tested, but they have a shorter shelf life because they require a relatively high moisture content to provide the desired texture. All bars may be eaten dry or mixed with hot or cold water.

Mineral behavior in processed fruits

The distribution of calcium and magnesium between the solid and liquid fractions of five canned fruits (peaches, pears, sweet cherries, prune plums, and apricots) packed in five different syrups (heavy sucrose, light sucrose, heavy honey, light honey, and pear juice) and water was studied. Mineral migration patterns, migration rates, and equilibrium levels were compared. Most of the minerals were transferred rapidly from fruit to syrup during processing and the hours following. Fruit mineral percentages decreased only about 5% from 24 h postprocess to 6 mo later. The various syrups had significantly different effects on mineral migration patterns and rates but did not significantly influence the final equilibrated values ($P < 0.01$). Water as a packing medium demonstrated the most profound migration rate effect, whereas the heavy sugar syrup was slowest. Final values varied significantly for the various fruits, and in all cases significantly more magnesium than calcium was released from the fruit into the syrup ($P < 0.01$). It was interesting to note that the use of pear juice as a packing medium resulted in a fruit mineral content that was almost as high as fresh fruit because the pear juice used was high in mineral content. With pear juice as the exception, between 35 and 50% of the fruit calcium and magnesium had leached into the syrup by the time the product would be consumed, representing a significant loss of available nutrients if the syrup is not consumed with the fruit.

Browning of pear juice concentrate

Nonenzymatic browning is a serious problem in fruit juices and concentrates, and occurs during thermal processing and storage. The problem is important locally in pear juice concentrate production, limiting the quality of locally produced pear juice concentrate and restricting the use of cull pear fruit. The effect of temperature and soluble solids (°Brix) on nonenzymatic browning in pear juice concentrate was determined by following absorbance at 420 nm over the temperature range of 50–80°C. Browning could be modeled as a zero-order-rate process. The data allow quantitative description and prediction of browning to be expected from thermal processes and, by extrapolation, suggest advantageous conditions for optimizing storage life relative to cost of storage.

Long-term (10 mo) storage trials indicate the predictive power of data collected at increased temperatures to be adequate for storage temperatures above 0°C. Below 0°C the reactions leading to color deterioration are markedly slower than would be predicted from data collected at above freezing temperatures.

Wine-making trials for the evaluation of new grape varieties and selections

The 1982 season was a "clean-up" year for the evaluation and elimination of cultivars that have been marginally retained in the program for several years. It was the year of preliminary evaluation for 10 new seedlings selected from the Summerland breeding program and 25 new varieties submitted from the British Columbia Ministry of Agriculture and Food (BCMAF) experimental plots. A total of 276 experimental wines from the 1982 harvest were prepared, analyzed, and evaluated during 1983. The 90 best wines were evaluated in blind taste tests tastings by British Columbia wineries during two workshops (white and red wines, respectively). Canadian wineries have intense, low-cost international competition in the domestic market and have identified that wines must bear delicate, attractive flavors to remain marketable. Historically, hybrid cultivars have borne disease resistance, good productivity, and winterhardiness but were often handicapped by intense, heavy flavors. The current program is converging on a short list of hybrids that have delicate "vinifera" character and on viniferas with disease resistance, winterhardiness, and adequate production.

POMOLOGY AND VITICULTURE

Repeated applications of residual herbicides on growth and yield of apple

Starkrimson Delicious apples on M26 rootstock planted in 1978 have received repeated applications of the residual herbicides terbacil, diruon, simazine, and dichlobenil once a year since 1980. The chemicals were applied at the recommended rate for the soil type, and at twice and four times the recommended rate. Under irrigated conditions on coarse, low-organic-matter soil, terbacil has provided the poorest weed control and simazine the best. Diuron and dichlobenil were only slightly less effective than simazine. Diuron caused some toxicity after the 1st yr and after 2 yr, trees treated with 10 kg/ha began to die. Trees treated with terbacil at a rate of 6 kg/ha or simazine at a rate of 10 kg/ha showed only light chlorosis and some necrosis of leaves in early summer and no mortality. Growth and yields, however, were severely reduced. Trees in plots treated with dichlobenil at a rate of 16 kg/ha had some leaves with yellow halos typical of this compound, but growth and yields were not reduced. The best yield was provided by the highest rate of dichlobenil. The orchard floor flora has been changed with repeated applications of the herbicides, each chemical favoring the establishment of different species.

The effect of postharvest storage temperature on ripening of apples

The onset of ripening activity by Golden Delicious apples harvested before the onset of rapid ethylene production can be delayed for several months by holding individual fruits at 15 or 20°C. To obtain this result, the fruits must be held in individual chambers aerated very slowly with a stream of ethylene-free air. These mature but unripe fruits remain fresh, firm, and disease-free and only slowly lose sugar and acidity. Fruits held in identical conditions but at 2–3°C start ripening within 1 wk and subsequently deteriorate. It is clear that low temperatures induce ripening of Golden Delicious apples.

In one season, but not in the next, McIntosh apples field-treated with Alar, a plant-growth regulator, responded similarly to Golden Delicious. Spartan apples have not displayed this characteristic. These findings may result in changes to existing methods of handling and storing Golden Delicious. Fruit intended for long storage should not be chilled before it is subjected to low O_2 or low-ethylene controlled-atmosphere (CA) storage.

Freezing injury to grapes

Freezing injury to buds and the xylem of grapes was observed to be associated with heat release resulting from the freezing of supercooled water within the tissue. This heat release was detected as an exotherm on the thermal profile of these tissues. The exotherm of the grape bud is a sharp peak and can be used to determine varietal resistance to freezing injury.

Adventitious shoot differentiation from immature apricot, cherry, and apple cotyledons

To study the potential for differentiation of adventitious shoot buds from apricots, cherries, and apples, immature embryos were cultured on Murashige and Skoog medium (MS) solidified with agar and supplemented with a variety of growth regulators. Of the three species, apricots developed shoot buds on the cultured embryos' cotyledons with highest frequency. The response of cherries was intermediate, and apples only occasionally differentiated. The most favorable growth-regulator combination for apricots was 5 μM benzyladenine (BA) plus 1 μM 2,4-D, but 5 μM alone and 1 μM 2,4-D alone were also effective. Cherries differentiated shoot buds only when BA, at a concentration of 0.1–5 μM, was used alone, and with this species, auxin was inhibitory. Differentiation was first indicated when small hemispherical protuberances were observed on the cotyledon surface on day 6. Transfer to media with 3 μM BA resulted in shoot elongation, and shoots were then rooted and apricot plantlets produced. Germination was also observed with immature apple embryos responding with the highest frequency. Germination was usually promoted by BA treatment.

Pear rootstocks

Swiss Bartlett pears were grafted in 1972–1973 onto seven Old Home × Farmingdale (OHF) clonal rootstocks, two clonal quinces, and Old Home and Bartlett seedlings. Twelve trees (representatives) of each rootstock–scion combination were planted in the orchard in 1974, at a spacing of 2.4 × 4.8 m, 850 trees per hectare. Performance for the first 10 yr in the orchard (1974–1983), based on annual and cumulative marketable yields, indicates that OHF clones 87, 515, 69, and 34 lead all other stocks in 10 yr of cumulative production by at least 40%, with size control adequate to suggest that the spacing of 2.4 × 4.8 m would be commercially acceptable for Swiss Bartlett on moderate soil. The two quinces, Angers and Provence, suffered sufficient crown injury as a result of early fall freezes to indicate that these rootstocks would be useful only for trees on a short-lived filler basis.

Allelopathic effect of quackgrass on apple seedlings

Quackgrass plants growing with apple seedlings in containers of Long Ashton complete nutrient solution reduced the growth of the apple seedlings. The solution of the quackgrass–apple containers was kept as similar as possible to the solution of control seedlings grown alone for nutrient levels and pH, and the quackgrass plants were not allowed to shade the seedlings in the same container. When apple seedlings were grown in a nutrient solution previously used to grow quackgrass but adjusted for nutrient levels, the growth of apple seedlings was also reduced. With the use of a modified stair-step experiment to separate the inhibitory effects of competition from those of allelopathy, growth retardation of apple seedlings by quackgrass was again demonstrated.

The effect of low-oxygen storage on scald control in Delicious apples

Low oxygen storage (0.5–1%) was investigated as a means of controlling scald in Delicious apples should chemicals no longer be available for this purpose. Apples harvested at commercial maturity did not develop scald in the 0.5% O_2 atmosphere, and only a slight amount developed in the 1% O_2 atmosphere. However, apples harvested 7–10 days earlier developed appreciable scald in both atmospheres and a scald-inhibiting chemical treatment was effective in control of the disorder. Storage of fruit in these low-O_2 atmospheres can result in anaerobic respiration and subsequent internal breakdown. Analysis of the ethanol content in the storage atmosphere followed by appropriate oxygen correction can eliminate the latter problem.

Lapins and Sunburst—new sweet cherries

Lapins was originally tested as 2D-28-26 and Sunburst as 2D-28-37, and both originated from a cross of Stella × Van in 1965. The self-fertility gene from Stella has been incorporated into both cultivars to allow planting without pollinizers, but both are universal pollen donors and excellent for pollinating other cultivars.

The fruit of Lapins is resistant to rain-induced splitting, better than other commercial varieties, large, and firm enough to withstand storage and transcontinental shipping. Eating quality is very good with most testers rating it higher than cultivars grown at present. The tree is upright with many fruiting spurs and has a desirable growth habit. Commercial testing for 10 yr has indicated that Lapins is better than cultivars grown at present, with its split resistance and late maturity being especially important attributes.

Sunburst is outstanding for large fruit (up to 22.5 g) and high yields. Its good fertility and high flower count should make it a good pollinizer cultivar, especially well suited to locations where good fruit set is difficult to achieve because of spring frost or wet weather at pollination time, for example. Sunburst is not as firm as some other cultivars but it has a slow rate of softening in storage. Its outstanding size, self-fertility and good fruit quality should make it popular in regions where fruit is sold soon after picking. It matures a day later than Van.

SOIL SCIENCE AND AGRICULTURAL ENGINEERING

Grape production under plastic mulch

In the second season of grape production, Foch grapes yielded 2.9, 8.1, and 10.8 kg per vine (independently of N treatments) under grass cover, bare soil with vegetation controlled by herbicides, and plastic mulch, respectively. The effects of N treatments were not significant, and there was no interaction between ground treatments and N. Foliage color in August, on a scale of 1–5 light to dark, averaged 1.9, 3.7, and 4.3 for grass, herbicide, and plastic and was again strongly correlated with the season's end yields.

At this stage of the experiment, the evidence is that plastic mulch, together with trickle irrigation under the mulch, is a successful cultural method of growing grapes. The economics of the technique have not been assessed, and there has not yet been a mild enough winter to allow any assessment of any effects of plastic mulch on vine damage caused by cold temperature.

Drainage flows in irrigated lysimeters

After the 1982 season of maximum irrigation of lysimeters (containing apple trees) equal to the Summerland irrigation district allotment, the rate of irrigation was reduced to 50% of maximum. Drainage from all lysimeters, either with sandy loam or silt loam soils, then returned to zero for the entire 1983 season. The 10-yr-old trees suffered no harm or setbacks from this low level of irrigation and produced a full crop of good-quality apples. This is strong evidence that irrigation rates of the district and indeed the whole Okanagan Valley are higher than necessary purely for crop production. If the mechanical and practical aspects of lower rates of irrigation can be solved, there is potential for reducing the quantities of water needed for irrigation. Ways to solve the mechanical problems need to be explored.

Cherry tree cover

A light, temporary cover for cherry trees was tested for its capability to protect the crop from rain-splitting. A row of five Lambert trees was covered with a semitransparent Permalon plastic roof supported by a framework attached to the trees. The main problem was lack of durability. Strong winds tore apart each version of the cover in about a week. A flat cover was more durable than a pitched-roof type.

Cherry splitting, however, was reduced from 60 to 30%. Much of the splitting was caused by a heavy rainfall, which unfortunately occurred when the covers were being switched. It appears that splitting could be virtually eliminated with a durable cover. Further experiments are planned.

Fruit dryers

Improvements were made in the performance of commercial fruit dryers. We found that airflow was increased 30% inside a dryer body by installing curved sheet-metal corners at the fan end of the unit. Airflow was also increased—and hence drying time reduced—by increasing the speed of the blower with a more powerful motor. Airflow uniformity (drying uniformity) was improved by a perforated plate normal to the airstream just upstream of the drying rack. High-speed portions of the airflow were retarded and some of the air was redistributed to adjacent slow-speed regions. The best plate had 13-mm holes on 19-mm centers (35% open area).

Ca, Mg, and K leaching in irrigated lysimeters

Intense irrigation and nitrogen fertilization has leached soil bases and lowered pH in irrigated orchards in British Columbia. Twelve lysimeters, each containing an Osoyoos sandy loam soil and a McIntosh apple tree, have been monitored for Ca, Mg, and K concentrations in soil, drainage water, tree leaves, and fruit from 1976 to 1980. Treatments included Kentucky bluegrass and clean cultivation combined with N fertilization rates of 162 or 324 kg/ha/yr applied as NH_4HO_3. Clean cultivation had the greatest effect on Ca and Mg concentrations, such that the highest Ca, Mg, and K losses frequently were measured in drainage from these plots. By 1981, exchangeable Ca, Mg, and soil pH at a soil depth of 0–10 cm in the cultivated plots, had significantly declined relative to the grass plots. However, neither cultivation nor fertilizer had altered Ca, Mg, or K concentrations of McIntosh fruit or foliage from 1976 to 1980. For all lysimeters, Ca and Mg leached more rapidly than K. Annual losses over all treatments, 1976–1980, averaged 387 kg/ha for Ca, 118 kg/ha for Mg, and 44 kg/ha for K. Such leaching would eventually result in K enrichment of soils relative to Mg and Ca. This is undesirable, because McIntosh trees are sensitive to Mg deficiency. Periodic additions of Ca and Mg, possibly with dolomitic lime, should be considered for such orchards.

Boron toxicity of peaches

B levels were measured in British Columbia peach orchards and the soil and leaves exhibited a range of B nutrition, including some cases of suspected B toxicity. B toxicity always occurred when B concentration in the leaves in May exceeded 130 μg/g, and frequently occurred when B concentration in the leaves in July was between 50 and 85 μg/g. Standards for B in leaves have been revised downward in the *Tree Fruit Production Guide* to a desirable range of 26–50 μg/g in July. For peaches, concentrations of B in leaves and in soil were generally correlated, although exceptions occurred when B in the soil was concentrated either near the soil surface or deep in the soil. In July, the concentration of B in leaves was between 26 and 50 μg/g when the concentration of B in the soil to a 90-cm depth ranged from 0.2 to 0.4 μg/mL of soil.

Relation of size of young apple trees grown on land previously in orchard to soil acidity and basic cations

Trunk circumferences of 5–10-yr-old apple trees grown on land previously in apple orchard were generally retarded and highly variable, but correlated well with the soil acidity measurements in four of the six orchards investigated. Size of Delicious, Tydeman, and Rome Beauty cultivars correlated positively with soil pH and negatively with soluble Al and Mn. Growth of McIntosh adjacent to the Delicious and Tydeman cultivars in two of the orchards did not correlate well with the characteristics of soil acidity. However, in the three orchards where only McIntosh were grown, tree size did correlate ($r = 0.72, 0.71, 0.52$) well with soil exchangeable Mg. Soil acidity and nutrient deficiencies should be considered, along with pathogens, for diagnosing the cause of retarded tree growth in replanted apple orchards.

PUBLICATIONS

Research

Angerilli, N. P. D.; Beirne, B. P. 1982. Mortality of introduced mosquito larvae in natural and artificial ponds containing aquatic vegetation. Prot. Ecol. 4:381-386.

Beveridge, T.; Jones, L.; Tung, M. A. 1983. Stranded structure developments in thermally produced whey protein concentrate gel. Food Micro. 2:161-163.

Cumming, D. B.; Stark, R.; Sanford, K. A. 1981. The effect of an individual quick blanching method on ascorbic acid retention in selected vegetables. J. Food Process. Preserv. 5(1):31-37.

Granger, R. L.; Looney, N. E. 1983. Radio-calcium uptake by 'Spartan' and 'Delicious' apple as influenced by rootstock and BA + GA_3 to activate growth of lateral buds. HortScience 18(3):314-316.

Hogue, E. J.; Neilsen, G. H.; Mason, J. F.; Drought, B. G. 1983. The effect of different calcium levels on cation concentration in leaves and fruit of apple trees. Can. J. Plant Sci. 63:473-479.

Hoyt, P. B.; Leitch, R. H. 1983. Effects of forage legume species on soil moisture, nitrogen and yield of succeeding barley crops. Can. J. Soil Sci. 63:125-136.

Knee, M.; Looney, N. E.; Hatfield, G. S.; Smith, S. M. 1983. Initiation of rapid ethylene synthesis by apple and pear fruits in relation to storage temperature. J. Exp. Bot. 34(146):1207-1212.

Lane, W. D. 1982. Plant manipulation in vitro with horomones. Proc. Int. Plant Prop. Soc. 31:101-108.

Lau, O. L.; Meheriuk, M.; Olsen, K. L. 1983. Effects of "rapid CA", high CO_2 and $CaCl_2$ treatments on storage behavior of 'Golden Delicious' apples. J. Am. Soc. Hortic. Sci. 108(2):230-233.

Leggett, M. E.; Rahe, J. E.; Utkhede, R. S. 1983. Survival of sclerotia of *Sclerotium cepivorum* Berk. in muck soil as influenced by drying and the location of sclerotia in soil. Soil Biol. Biochem. 15:325-327.

McPhee, W. J.; Nestmann, E. R. 1983. Predicting potential fungicide resistance in fungal populations by using a continuous culturing technique. Phytopathology 73(9):1230-1233.

Meheriuk, M.; Lane, W. D. 1983. A comparison of fruit from spur and standard 'McIntosh' at harvest and after controlled-atmosphere storage. HortScience 18(2):220-221.

Mnkeni, A. P.; Beveridge, T. 1982. Thermal destruction of pteroylglutamic acid in buffer and model food systems. J. Food Sci. 47:2038.

Neilsen, G. H.; Hoyt, P. B.; Lau, O. L. 1982. Effects of surface soil pH on soil cation content, leaf nutrient levels and quality of apples in British Columbia. Can. J. Plant Sci. (62):695-702.

Neilsen, G. H.; Stevenson, D. S. 1983. Leaching of soil calcium, magnesium and potassium in irrigated orchard lysimeters. Soil Sci. Soc. Am. J. (47):692-696.

Quamme, H. A. 1983. Relationship of air temperature to water content and supercooling of overwintering peach flower buds. J. Am. Soc. Hortic. Sci. 108:697-701.

Quamme, H. A.; Spearman, G. A. 1983. 'Harvest Queen' and 'Harrow Delight' pear. HortScience 18:770-772.

Thwaite, W. G.; Madsen, H. F. 1983. The influence of trap density, trap height outside traps and trap design on *Cydia pomonella* (L.) captures with sex pheromone traps in New South Wales apple orchards. J. Aust. Soc. 22:97-99.

Utkhede, R. S. 1982. Effect of six herbicides on the growth of *Phytophthora cactorum* and a bacterial antagonist. Pestic. Sci. (13):693-695.

Utkhede, R. S. 1983. Inhibition of *Phytophthora cactorum* by bacterial isolates and effects of chemical fungicides on their growth and antagonism. J. Plant Dis. Prot. 90(2):140-145.

Utkhede, R. S.; Rahe, J. E. 1983. Antagonist × pathogen interaction for biological control of onion white rot. Phytopathology 73:890-893.

Utkhede, R. S.; Rahe, J. E. 1983. Chemical and biological control of onion white rot in muck and mineral soils. Plant Dis. (67):153-155.

Utkhede, R. S.; Rahe, J. E. 1983. Effect of *Bacillus subtilis* on growth of onion and white rot. J. Phytopathol. 106:199-203.

Utkhede, R. S.; Rahe, J. E.; Coley-Smith, J. R.; Van der Meer, Q. P.; Brewer, J. G.; Crisola, V. 1982. Genotype-environment interactions for resistance to onion white rot. Can. J. Plant Pathol. 4:269-271.

Walker, A.; Hance, R. J.; Allen, J. G.; Briggs, G. G.; Chen, Yuh-Lin; Gaynor, J. D.; Hogue, E. J.; Malquori, A.; Moody, K.; Moyer, J. R.; Pestemer, W.; Rahman, A.; Smith, A.E.; Streibig, J. C.; Torstensson, N. T. L.; Widyanto, L. S.; Zandvoort, R. 1983. EWRS herbicide–soil working group: Collaborative experiment on simazine persistence in soil. Weed Res. 23:373-383.

Webber, M. D.; Hoyt, P. B.; Corneau, D. 1982. Soluble Al, exchangeable Al, base saturation and pH in relation to barley yield on Canadian acid soils. Can. J. Soil Sci. 62:397-405.

Miscellaneous

Banham, F. L. 1982. An improved management program for the peach twig borer. Can. Agric. 27(3):21-23.

Chau, T. H.; Dyck, V. A. 1982. Assessment of *Pseudogonatopus flavifemur* E & H (Dryinidae: Hymenoptera) as a biocontrol agent of the rice brown plant hopper. Proceedings International Conference on Plant Protection in the Tropics, pp. 253-265.

Denby, L. G.; Meheriuk, M. 1982. Precocity of Swiss Bartlett pears on clonal and seedling rootstocks. Acta Hortic. 124:51-56.

Looney, N. E. 1983. Growth regulator usage in apple and pear production. Pages 1-26 *in* Nickell, L. G., ed. Plant growth regulating chemicals. C.R.C. Press, Boca Raton, FL.

Looney, N. E. 1983. Growth regulator use in the production of *Prunus* species fruits. Pages 27-28 *in* Nickell, L. G., ed. Plant growth regulating chemicals. C.R.C. Press, Boca Raton, FL.

Neilsen, G. H. 1982. Orchard nutrition in the Okanagan Valley. Can. Agric. 3(27):23-27.

Porritt, S. W.; Meheriuk, M.; Lidster, P. D. 1982. Postharvest disorders of apples and pears. Agric. Can. Publ. 1737. 66 pp.

Quamme, H. A.; Stushnoff, C. 1983. Resistance to environmental stress. Pages 242-266 *in* Moore, J. N.; Janick, J., eds. Methods of fruit breeding. Purdue Press.

Quamme, H. A.; Stushnoff, C. 1983. Breeding crops for resistance to environmental stress. Pages 242-266 *in* Moore, J. N.; Janick, J., eds. Methods of fruit breeding. Purdue Press.

Sansovini, S.; Lane, W. D. 1983. Sunburst and Lapins ciliege autofertili durone-simili. Pages 55-57 *in* Nuoro acquisizioni del miglioramento genetico italiano in fruitticoltura. Societa Orticda Italiana.

Stevenson, D. S. 1982. Growing wine grapes under trickle irrigation. Can. Agric. 27:35-37.

Stushnoff, C.; Quamme, H. A. 1983. Adaptation to specific climatic and soil environments. Pages 267-273 *in* Moore, J. N.; Janick, J., eds. Methods of fruit breeding. Purdue Press.

Research Station

Vancouver, British Columbia

PROFESSIONAL STAFF

M. Weintraub, B.A., Ph.D., F.N.Y.A.S.	Director
C. A. Gray,[1] B. Comm.	Administrative Officer

Scientific Support

T. Matsumoto,[2] B.S.A., M.Sc., M.L.S.	Librarian

Statistical Services

J. W. Hall, M.Sc., Ph.D.	Regional Statistician

Entomology

A. R. Forbes, B.A., M.S., Ph.D., F.E.S.C.	Head of Section; Virus vectors
W. T. Cram, B.S.A., M.S., Ph.D.	Strawberry insects, ecology
B. D. Frazer, B.Sc., Ph.D.	Aphid ecology
J. Raine, B.S.A., M.S.	Berry insects, leafhopper vectors
S. Y. S. Szeto, B.Sc., M.Sc.	Pesticide chemistry
R. S. Vernon, B.Sc.. M.P.M., Ph.D.	Vegetable insects
A. T. S. Wilkinson, B.S.A.	Soil insects, biological control of weeds

Plant Pathology

R. Stace-Smith, B.S.A., Ph.D., F.A.P.S.	Head of Section; Raspberry viruses, virus characterization
H. A. Daubeny, B.S.A., M.S.A., Ph.D.	Plant breeding, small fruits
S. H. De Boer, B.Sc., M.Sc., Ph.D.	Bacterial diseases
R. R. Martin, B.S., Ph.D.	Strawberry viruses
H. S. Pepin, B.S.A., M.A., Ph.D.	Root rots, red stele of strawberry
T. C. Vrain, D.E.A., Ph.D.	Nematology
N. S. Wright, B.S.A., M.S.A., Ph.D.	Potato diseases, serology

Virus Chemistry and Physiology

H. W. J. RAGETLI, Ir., Ph.D.	Head of Section; Chemistry and ultrastructural cytopathology of viruses
R. I. HAMILTON, B.Sc., M.Sc., Ph.D.	Virology, virus interaction and seed transmission
G. G. JACOLI, B.A., Ph.D.	Biochemical virology
J. H. TREMAINE, B.Sc., M.Sc., Ph.D.	Biophysical virology

Honorary Research Associate and Editor

F. C. MELLOR, B.S.A.	Virus eradication

Departures

C. M. CUTLER, B.A., M.L.S. Transferred to Lethbridge Research Station as Area Coordinator 1 December 1983	Library Coordinator, Pacific area
H. A. REID Transferred to Pacific Region Headquarters, Research Branch, 5 September 1983	Administrative Officer

Graduate students

S. BARNABE, B.Ed.	Entomology
H. CONTANT, M.Sc.	Entomology
K. GILES, B.Sc.	Entomology
G. KALMAR, M.Sc.	Virus chemistry and physiology
B. LYONS, M.Sc.	Entomology
R. B. SMITH, M.Sc.	Entomology
P. THERRIEN, M.Sc.	Entomology

---

[1] Reported for duty 3 January 1984.

[2] Seconded from Libraries Division, Finance and Administration Branch.

INTRODUCTION

This is the 21st annual report of the Vancouver Research Station in which highlights of our research programs are summarized. The Station has dual functions: it is the national center for plant virus research and it is also responsible for regional problems in plant pathology and entomology.

In 1983, we emphasized two areas, each with new and exciting possibilities for plant disease diagnosis and control. The biotechnology program has resulted in significant progress in the production of monoclonal antibodies for plant viruses in small fruits and for specific bacteria that are of considerable economic consequence; the cDNA research, for diagnosis of viruslike agents, is also proceeding satisfactorily. The second area of expanded interest is in integrated pest management and biological control of pests, which now includes a variety of insects and nematodes.

Further details of research or reprints of this report or publications listed can be obtained from the scientist or the Research Station, Agriculture Canada, 6660 N.W. Marine Drive, Vancouver, B.C. V6T 1X2.

M. Weintraub
Director

VIRUS CHEMISTRY AND PHYSIOLOGY

Virus infection

To determine the minimum wound size for effective virus establishment, leaves were abraded with diamond powders in five narrow size ranges, between 0 and 22 μm. The diamond powder with 8–12 μm particles produced optimum infection rates with tobacco mosaic virus and tobacco necrosis virus on *Nicotiana glutinosa* and *Phaseolus vulgaris*, respectively. Depth of the wound and number of cells wounded simultaneously are crucial for effective infection. Hair cells do not appear to be effective entry ports.

Biological properties of viruses

Cowpea (California Blackeye) doubly infected with southern bean mosaic virus (SBMV-C) and tobacco mosaic virus (TMV-C) were significantly reduced in height, fresh weight and seed compared with SBMV-C-infected or virus-free plants. Only TMV symptoms were visible. Titre of both viruses in primary leaves was less than in single infections, but SBMV-C titre was enhanced fivefold in trifoliate leaves. There was no evidence of genomic masking. SBMV-C induced few local lesions in an African cowpea (V45-Botswana), but the double infection facilitated systemic spread. SBMV-C alone produced symptomless infection of primary leaves of French bean (Pinto), but double infection induced local necrotic lesions, the number depending on the concentration of SBMV-C.

Ultrastructural responses to virus infections

Leaf tissues of two garden-grown single flower dahlia plants, naturally infected with tomato spotted wilt virus, showed cytopathology characterized by typical membrane-bound viral aggregates and by a severe and novel chloroplast degeneration. The latter consisted of a massive enlargement, up to 1 μm of the osmiophilic bodies, many of which were ejected into the cytoplasm or central vacuole. Ejection was preceded or accompanied by the formation on the chloroplast membrane of a foamlike structure up to 0.3 μm thick, which surrounded one or more osmiophilic bodies. Sections of tonoplast bounded these new composite spheres when they moved into the central vacuole.

Virus transmission by seed and pollen

Electron microscopic examination of sections of pollinia from commercial *Cattleya* and *Cymbidium* plants infected with cymbidium mosaic and odontoglossum ringspot virus, respectively, revealed viruslike particles typical of potex and tobamo viruses in the cytoplasm. The role of infected pollen in the epidemiology of the two viruses is being studied in a series of controlled crosses with virus-free female parents.

Little cherry disease (LCD)

Although characteristic inclusions detected by electron microscopy contribute clear evidence for LCD, tree removal is, for practical reasons, still based solely on fruit symptoms. A 3-yr study of a group of sweet cherry orchard trees with questionable fruit symptoms or with apparently normal fruit showed the presence of the diagnostic inclusions; these trees constitute continuous sources of LCD infection, undermining the effectiveness of the eradication program. Viruslike rods isolated from leaves of several presumably healthy Mazzard F 12/1 stool cuttings indicated the possible introduction of LCD via infected commercial understock.

The yield of dsRNA from young bark tissue of LCD-infected trees was greatest (5 $\mu g/g$) in May and June. Electrophoretic analysis revealed various numbers and quantities of dsRNAs from various locations. A more complex pattern was found in infected sweet cherry trees from Summerland than in those from Vancouver. Isolation of highly purified single components of the dsRNAs for radioactive end labeling with ^{32}P is in progress, to be used as a probe for RNA–RNA hybridization analysis.

PLANT PATHOLOGY

Virology

Three hybridoma clones that secrete antibodies specific to potato leaf roll virus (PLRV) were produced by somatic cell fusion between a mouse myeloma cell line and spleen cells from BALB/c mouse immunized with PLRV. Ascitic fluid from the hybridoma clones has titers as high as 10^8 in an indirect enzyme-linked immunosorbent assay (ELISA) using leaf sap from PLRV-infected potato and goat anti-mouse peroxidase conjugate. Clones produced antibodies in the subclass IgG1 and IgG2a as determined by elution properties from a protein A affinity column. Two of the hybridoma clones were specific, reacting with 53 PLRV isolates tested and not reacting with other luteoviruses.

Ten monoclonal antibodies have been prepared against raspberry bushy dwarf virus (RBDV) and three against an uncharacterized virus from *Rubus*, which resembles tobacco streak virus. Serological testing for these viruses in *Rubus* spp. is now possible by using the ELISA technique. One of the RBDV monoclonal antibodies reacted with all isolates of RBDV that were tested, including isolates from England, Scotland, Australia, and North America.

A survey was initiated in 1983 to determine the virus status of several experimental and quarantine grapevine plantings in British Columbia. The ELISA test was used to index plants for each of three sap-transmissible viruses: grapevine fanleaf (GFLV), arabis mosaic (AMV), and tomato ringspot (TomRSV). A total of 2551 plants were sampled, representing 11 vineyards and 100 cultivars. None of the plants were infected with TomRSV but two were infected with GFLV and 15 with AMV.

A survey of red raspberry plantings in British Columbia and Washington State indicated that TomRSV was widespread, particularly in Washington. The virus was readily detected in most instances by using the double sandwich ELISA procedure, but the test failed to detect all isolates of the virus. Isolates from one planting were serologically related to TomRSV, but the relationship was so distant that the virus was not detected by ELISA with the use of an antiserum source that was able to detect a wide range of isolates.

Virus-free potatoes

The Vancouver collection of virus-free potatoes includes all 68 cultivars licensed for sale as seed in Canada as of 2 December 1982. It also contains the three Fredericton seedlings (F 70021, F 73008, and F 74123) and a Guelph seedling (G 670-11), which in 1983 became candidates for licensing. Additions to the collection in 1983 included the cultivars Coliban, Purple Chief, Sangre, and Talisman; three seedlings each from Fredericton, Idaho, and New York; and one seedling from North Dakota. Virus-free clones of these were developed by heat therapy and meristem tip culture.

Tests for potato virus X (PVX) and potato virus S (PVS) were applied in 1983 to all plots and fields comprising 124.4 ha of Elite and Foundation seed potatoes on 22 farms in Pemberton and Cariboo, B.C. Neither virus was found on 19 of the farms; all plots or fields found free of PVX and PVS in 1983 were grown from seed lots rated virus-free in 1982. On the three farms where infection was found, it was evident that the incidence of infection increased in the annual propagation of an infected seed stock, i.e., from Elite 2 to Elite 3, or Elite 3 to Foundation, and that virus may be spread from one class or seed lot to another on the same farm. The results illustrate the difficulty of avoiding spread of these highly infectious viruses when even a trace of infection occurs in any seed lot on the farm.

Small fruits

Strawberry. In 1982 and 1983 performances of two advanced selections, BC 69-5-34 and BC 76-007-20, from the British Columbia strawberry breeding program indicated that each justified continued propagation for wide-scale testing. Each shows at least as much virus tolerance as Totem and usually outyielded it in trial plantings at Abbotsford and in the Pacific Northwest regional trials. Neither selection has processed-fruit quality equal to that of Totem, but their fresh-fruit quality is probably superior.

Extension of shelf-life of strawberry fruit has become more important in British Columbia since a greater proportion of the crop now goes to fresh-market outlets. Fruit traits associated with longer shelf life are bright red, nondarkening color, firmness, and low susceptibility to rot. In 1983 cultivars and selections were evaluated for these traits under simulated commercial conditions by placing boxes of freshly picked fruit at 4°C for 48 hr, followed by 48 or 72 hr at ambient temperatures. Most cultivars and selections examined showed little rot under these conditions, indicating that progress has been made in obtaining fruit rot resistance.

Raspberry. The fungicide Ridomil was evaluated as a soil drench to control root rot caused by *Phytophthora* in several commercial fields and, in combination with Nemacur or Vydate, to control root rot and nematodes. Where nematodes were not a problem, Ridomil gave very good control as measured by increased vigor and number of canes. Where nematodes were a problem, neither Ridomil nor nematicide alone gave adequate control, but when used in combination, they gave good control.

High levels of resistance to spur blight of raspberry canes have been found in clones of the native North American red raspberry. The resistance is much greater than that observed in any cultivar. The resistance has been transmitted to F_1 progenies from the crosses of selected native clones with the cultivar Skeena. Back-cross progenies involving resistant F_1 selections will be evaluated for resistance in 1984 and 1985.

Bacteriology

Two hybridoma cell lines were developed that produce monoclonal antibodies to *Corynebacterium sepedonicum*, the causal agent of bacterial ring rot of potato. Preliminary evidence suggests that the monoclonal antibodies produced by one of the hybridomas react with a protein antigen and those produced by the other react with a carbohydrate component. Both monoclonal antibody preparations reacted with all 20 *C. sepedonicum* strains tested, but not with any of 10 other plant pathogenic corynebacteria. However, one of the monoclonal antibody preparations reacted with three out of 12 nonpathogenic bacteria isolated from potato stems; the other did not react with any of those strains, and it was used extensively in screening potato tuber and stem tissue with immunofluorescence for the presence of *C. sepedonicum* cells. In a significant number of preparations from ostensibly healthy potato plants, one to five fluorescing cells were observed, but they could not be unequivocally related to the presence of the ring rot pathogen. (The research was supported in part by a Farming for the Future grant awarded by the Agricultural Research Council of Alberta.)

Preparations of bacterial-ring-rot-infected potato tubers and stem tissue reacted with antisera produced in rabbits against *Corynebacterium sepedonicum*. Precipitin bands that developed in agar immunodiffusion corresponded to bands that developed with pure broth cultures of the organism. As a confirmatory test for active ring rot infections, agar immunodiffusion was just as useful as immunofluorescence. However, agar immunodiffusion was insufficiently sensitive to detect low levels of the ring rot bacterium in symptomless potato tissue. Furthermore, *C. sepedonicum* strains with a nonmucoid colony morphology reacted poorly or not at all in this test.

ENTOMOLOGY

Vectors

Little cherry disease. Fruit symptoms were induced in indicator trees by wood grafts from four trees in the Chilliwack area of British Columbia. Fruit symptoms were also induced in bearing trees by wood from trees inoculated with Dodder, thus establishing Dodder as a vector of LCD. Red leaf symptoms were induced in 10 out of 12 Sam indicator trees at Vancouver, and to date electron microscopic inclusions associated with LCD were transferred to two trees by the apple mealybug, *Phenacoccus aceris* (Sign.). Long flexuous rods (either virus particles or P-protein) were found in the stylet food canal of an infectious mealybug by electron microscopy.

Strawberry aphids. The rate of hatch of overwintered eggs of the strawberry aphid, *Chaetosiphon fragaefolii* (Cockerell), at five temperatures in controlled-environment chambers was used to determine the thermal threshold of development. Samples of eggs were taken from two field locations several times before egg hatch. These samples were subdivided and placed into two or three different constant-temperature chambers. The degree-day requirements for hatching from the time of collection were estimated. These estimates were found to correspond to the number of degree-days actually accumulated in the field between the time of egg collection and the time of hatching.

The attractiveness to winged aphids of cardboard cards painted with different colors, hues, and tints was assessed. The cards were placed either in or around strawberry fields or in fallow ground between fields. A variety of trap orientations to prevailing wind and trap designs were also evaluated. STP ® oil treatment was as effective as STICKEM Special ® in holding aphids that alighted on the trap and had the added advantage of allowing most larger insects to escape, thus preventing premature fouling of the trap.

Aphid survey. New records brought the number of known aphid species in British Columbia to 351. Aphids have now been collected from 743 different host plants, and the total number of aphid—host plant associations is 1376.

Pests of small fruits. In field tests the following were effective against the black-headed fireworm, *Rhopobota naevana* (Hbn.), on cranberry: Diazinon 50EC with active ingredient (a.i.) at 1.5 kg/ha; Lorsban 24EC at 0.48; Sevin 25SL at 2.31; Sevin XLR at 1.92; Dylon 4LS at 1.16; Decis 2.5EC at 0.0075; fenvalerate 30EC at 0.075; and Ambush 50EC at 0.075.

In field tests the following were effective against the Bruce spanworm, *Opheroptera bruceata* (Hulst.), on blueberry: Decis 2.5EC with a.i. at 0.005 kg/ha; Diazinon 50EC at 1.25 and 0.75; Malathion 50EC at 1.9; and Ambush 30EC at 0.05. Malathion 50EC with a.i. at the current recommended rate of 1.25 kg/ha was not effective, possibly because temperatures in March when sprays were applied were too cold (below 20°C).

In cooperation with a nematologist at Simon Fraser University, we investigated the effectiveness of the parasitic nematode *Heterorhabditis heliothidis* (Kahn et al.) for control of larvae, pupae, and adults of the black vine weevil, *Otiorhynchus sulcatus* (F.). In the field, mortality of black vine weevil larvae and pupae in the soil was observed after a surface spray application of 50 000 nematodes per litre per 8.6 linear meters of row of infested strawberry plants (about 1100 L/ha). A reliable assessment of the degree of control was not obtained in this preliminary field trial. There were some survivors that transformed to adult weevils, emerged from the soil, and fed on leaves in the treated plots. In the laboratory, healthy adult weevils were killed about 10 days after feeding on strawberry foliage that had been dipped in a nematode suspension of 4000 nematodes per litre. Nematodes successfully matured and reproduced, and offspring emerged from the adult weevil cadavers. This approach to weevil control is continuing.

The population responses of the two-spotted spider mite, *Tetranychus urticae* Koch, were studied at three densities of an organophosphate-resistant predator mite, *Phytoseiulus persimilis* Athias-Herriot, and at five plot sizes in a field of Totem strawberries. *T. urticae* numbers increased from 10 to 85 actives per leaflet during June and July when weather was cool and wet. The number then decreased to 4.4 actives per leaflet during a hot dry period in August. *P. persimilis* spread to all controls but one. An unknown native predator was found in all plots and in numbers that were inversely proportional to the number of *P. persimilis*. Preliminary results of laboratory experiments suggest that predation was responsible for the synchronous decline of *T. urticae* in all field plots during August. Further work is being planned to look at the following: the occurrence and biology of the unknown predator; the possibility of developing a predator that will function efficiently at lower temperatures; economic thresholds for *T. urticae*; and predator-to-prey ratios that will provide effective controls of *T. urticae*.

Lettuce aphid, Nasonovia ribisnigri (Mosley). A minor-use registration was obtained for pirimicarb against the lettuce aphid on the basis of our 1982 studies. Commercial lettuce growers who used the spray program developed by us suffered no losses this year, compared with a million-dollar loss in 1982.

Asparagus aphid, Brachycolus asparagi (Mordvilko). A 3-yr field study to develop a chemical control program for the asparagus aphid was successfully completed. Extensive efficacy and residue data were the basis for the minor-use registration just approved for pirimicarb and methamidophos. Residue data for the marketable spears harvested from fields treated with disulfoton, oxydemeton-methyl, methamidophos, dimethoate, and pirimicarb in 1982 were also determined.

Weeds. Rhinonchus pericarpius, whose larvae have been found seriously damaging the roots and crowns of broad-leaved dock in some areas of the lower Fraser Valley, was studied in the laboratory. Under laboratory conditions 40–80 larvae killed the plants, but when the test was repeated outdoors the plants were affected initially but recovered quickly. In both tests there was no competition from other plants, as occurs in pasture. A combination of weevil damage plus competition from other plants in forage and pasture may give some control of the weed. A study of the life history of this insect showed that it is univoltine and that it overwinters as an adult.

The cinnabar moth, released near Nanaimo, B.C., in 1964 to control tansy ragwort, has stabilized at a very low ineffectual population, causing damage to less than 5% of the flowering plants. At the Abbotsford release site, the cinnabar population also declined but flea beetle whose larvae mine the roots and crowns, was found throughout the 14-ha site near Nanaimo and averaged 14.5 larvae per root. The low level of tansy ragwort found at the Nanaimo site for the past 3 yr may be a result of the increasing *L. jacobaeae* population.

Residue chemistry

Foliar sprays of Systox 2.4SC (demeton) with a.i. at 0.56 kg/ha, Di-Syston 8EC (disulfoton) with a.i. at 1.12 kg/ha, Cygon 4E (dimethoate) with a.i. at 1.12 kg/ha, and Pirimor 50WP (pirimicarb) with a.i. at 0.50 kg/ha were evaluated for the second time for control of the European asparagus aphid, *Brachycolus asparagi*, in Summerland, B.C.

After insecticide application, the two isomers of demeton, demeton-S and demeton-O, oxidized rapidly to their sulfoxides and sulfones. The parent compound was not detected after 6 days. The total residues (the sulfoxides plus sulfones) persisted for about 60 days. There were about 0.5 ppm after 40 days. Similarly, disulfoton oxidized rapidly to its sulfoxides and sulfones after application. The total residues were less than 0.1 ppm after 60 days. Dimethoate was partly oxidized to its oxon in asparagus ferns. The parent compound and the oxon degraded readily. There were less than 0.5 ppm of total residues (dimethoate plus dimethoxon) after 33 days. Pirimicarb metabolized rapidly in asparagus, yielding the desmethyl analogues or formyl methylamino analogues. The total residues of pirimicarb, including the metabolites, were the least persistent among the fern insecticides tested. There were less than 0.01 ppm remaining in the ferns after 40 days.

Marketable spears harvested the following spring were analyzed for residues and none were detected in any of the spear samples. The limit of detection was 0.002 ppm for each insecticide and its metabolites.

Dimethoate residues in asparagus. Foliar sprays of Cygon 4E (dimethoate) with a.i. at 1.12 kg/ha were evaluated for control of the European asparagus aphid, *B. asparagi*, in mature and immature asparagus. After insecticide application, dimethoate was partly oxidized to its oxon in asparagus. The total residues (dimethoate plus dimethoxon) disappeared rapidly. They were less than 0.5 ppm after 33 days. No residue was detected in samples of asparagus spears harvested the following spring (limit of detection 0.002 ppm).

Demeton residues in asparagus. Foliar sprays of Systox 2.4SC (demeton) with a.i. at 0.56 kg/ha were evaluated for control of the European asparagus aphid, *B. asparagi*, on mature and immature asparagus. After insecticide application, the two isomers of demeton, demeton-S and demeton-O, oxidized rapidly to their sulfoxides and sulfones. There were about 0.5 ppm of total residues after 40 days. However, no residue was detected in samples of asparagus spears harvested the following spring (limit of detection 0.002 ppm).

Disulfoton residue in asparagus. Foliar sprays of Di-Syston 8EC (disulfoton) with a.i. at 1.12 kg/ha were evaluated for the second time in 1982 for control of the European asparagus aphid, *B. asparagi*, in mature and immature asparagus. After insecticide application, disulfoton oxidized rapidly to its sulfoxides and sulfones. Less than 0.1 ppm total residue was present in fern tissue after 60 days. No residue was detected in samples of asparagus spears harvested the following spring (limit of detection 0.002 ppm). These findings are in agreement with those of the 1981 field trials.

Pirimicarb residues in asparagus. Foliar sprays of Pirimor 50WP (pirimicarb) with a.i. at 0.50 kg/ha were evaluated for control of the European asparagus aphid, *B. asparagi*, in mature and immature asparagus. After insecticide application, pirimicarb was partly converted to the desmethyl- or formyl methylamino-analogues. The total residues disappeared rapidly on asparagus ferns. Only trace amounts (< 0.01 ppm) remained after about 40 days. No residue was detected in samples of asparagus spears harvested the following spring (limit of detection 0.002 ppm).

PUBLICATIONS

Research

Brunt, A. A.; Stace-Smith, R. 1983. Hypochoeris mosaic. Commonwealth Mycological Institute and Association of Applied Biologists. Descriptions of plant viruses No. 273. 4 pp.

Daubeny, H. A. 1983. Red raspberry breeding in British Columbia. HortScience 18:268.

De Boer, S. H. 1983. Evaluation of an agar immunodiffusion procedure for confirming bacterial ring rot diagnoses. Am. Potato J. 60:661-669.

Fisher, L. J.; Hall, J. W.; Jones, S. E. 1983. Weight and age at calving and weight change related to first lactation milk yield. J. Dairy Sci. 66:2167-2172.

Forbes, A. R.; Chan, C.-K. 1983. The aphids (Homoptera: Aphididae) of British Columbia. 11. Further additions. J. Entomol. Soc. B.C. 80:51-53.

Forbes, A. R.; Chan, C.-K.; Foottit, R. 1982. The aphids (Homoptera: Aphididae) of British Columbia. 10. Further additions. J. Entomol. Soc. B.C. 79:75-78.

Forbes, A. R.; Mackenzie, J. R. 1982. The lettuce aphid, *Nasonovia ribisnigri* (Mosley) damaging lettuce crops in British Columbia. J. Entomol. Soc. B.C. 79:28-31.

Kutney, J. P.; Townsley, P. M.; Jacoli, G. G. 1983. Cultivation of *T. wilfordii* tissue culture for the culture for production of the cytotoxic diterpene tripdiolide. Plant Med. 29:1182-1187.

Majak, W.; Cheng, K.-J.; Hall, J. W. 1982. The effect of cattle diet on the metabolism of 3-nitropropanol by ruminal microorganisms. Can. J. Anim. Sci. 62:855-860.

Majak, W.; Howarth, R. E.; Cheng, K.-J.; Hall, J. W. 1983. Rumen conditions that predispose cattle to pasture bloat. J. Dairy Sci. 66:1683-1688.

Martin, R. R.; Converse, R. H. 1982. An improved buffer for mechanical transmission of virus from *Fragaria* and *Rubus*. Acta Hortic. 29:69-74.

Ramsdell, D. C.; Stace-Smith, R. 1983. Blueberry leaf mottle. Commonwealth Mycological Institute and Association of Applied Biologists. Descriptions of plant viruses No. 267. 4 pp.

Szeto, S. Y. S.; Vernon, R. S.; Brown, M. J. 1983. The degradation of disulfoton in soil and its translocation into asparagus. J. Agric. Food Chem. 31(2):217-220.

Townsley, P. M.; Kutney, J. P.; Jacoli, G. G. 1983. The recycling air lifter-transfer fermentor for plant cells. Biotechnol. Lett. 5/1:13-18.

Tremaine, J. H.; Hamilton, R. I. 1983. Southern bean mosaic virus. Commonwealth Mycological Institute and Association of Applied Biologists. Descriptions of plant viruses No. 274 (No. 57 revised). 6 pp.

Tremaine, J. H.; Ronald, W. P.; McGauley, E. M. 1983. Effect of sodium dodecyl sulfate on some isometric plant viruses. Phytopathology 73:1241-1246.

Vernon, R. S.; Borden, J. H. 1983. Dispersion of marked-release *Hylemya antiqua* (Meigen) (Diptera: Anthomyiidae) in an onion field. Environ. Entomol. 12:646-649.

Vernon, R. S.; Borden, J. H. 1983. Spectral specific discrimination by *Hylemya antiqua* and other vegetable-infesting species. Environ. Entomol. 12:650-655.

Vrain, T. C.; Dupré, M. 1982. Distribution des nématodes phytoparasites dans les sols maraîchers du sud-ouest du Quebec. Phytoprotection 63:79-85.

Vrain, T. C.; Lalik, B. 1983. Distribution and pathogenicity of the alfalfa stem nematode *Ditylenchus dipsaci* in British Columbia. Plant Dis. 67:300-302.

Wright, N. S. 1983. Uniformity among clones of ten potato cultivars. Am. Potato J. 60:381-388.

Miscellaneous

Daubeny, H. A. 1983. Breeding for insect, mite and nematode resistance. Pages 216-241 *in* Moore, I. N.; Janick, J., eds., Methods in fruit breeding. Purdue University Press.

Daubeny, H. A. 1983. Expansion of genetic resources available to red raspberry breeding programs. Proceedings 21st International Horticultural Congress 1:150-155.

De Boer, S. H. 1982. Survival of plant pathogenic bacteria in soil. Pages 285-306 *in* Mount, M. S.; Lacy, G. H., eds., Phytopathogenic prokaryotes. Vol. I. Academic Press.

Freeman, J. A.; Pepin, H. S. 1983. Strawberry and raspberry fruit rot control in British Columbia. Can. Agric. 2:26-29.

Hamilton, R. I. 1983. Certification schemes against seed-borne viruses in leguminous hosts, present status and further areas for research and development. Seed Sci. Technol. 11:1051-1062.

Hamilton, R. I.; Valentine, B. 1983. Virus-like particles in pollinia of *Cattleya* and *Cymbidium*. Proceedings 4th International Congress Plant Pathology, Melbourne, Australia.

Molefe, T. L.; Wakarchuk, D. A.; Kalmar, G.; Hamilton, R. I. 1983. Interaction of the cowpea strain of southern bean mosaic and tobacco mosaic viruses in cowpea and bean. Proceedings 4th International Congress Plant Pathology, Melbourne, Australia.

Molefe, T. L.; Wakarchuk, D. A.; Kalmar, G.; Hamilton, R. I. 1983. Replication of the cowpea strain of southern bean mosaic virus in Pinto bean. Proceedings 9th Meeting International Working Group of Legume Virologists, Binna Burra, Australia.

Weintraub, M. 1983. Profile. Vancouver Research Station. Can. Agric. 2:3.

PROGRAM STRUCTURE OF THE RESEARCH BRANCH

Departmental aim

The basic aim for Agriculture Canada, within the framework of overall government objectives and in cooperation with provincial governments, is to develop and assist the Canadian agricultural and food system, to provide for the needs of Canadians, for export markets, and for international aid commitments in a manner that ensures (*a*) a dependable supply of safe, nutritious food at reasonable prices to consumers, and (*b*) equitable returns to producers and processors.

Objectives and subobjectives

LAND RESEARCH

To assist in ensuring the maintenance, availability, and better utilization of agricultural land to meet current and future agricultural and food production needs.

1 Soil management and conservation

To obtain an understanding of the properties that limit the productivity of selected soils.

2 Land inventory and evaluation

To obtain a reliable inventory of Canadian soils and to develop improved methods for their characterization, classification, and evaluation.

WATER RESEARCH

To assist in more effective and efficient utilization of water resources for agricultural production.

1 Irrigation, drainage, and desalinization

To improve water management, irrigation, and drainage on Canadian soils in order to increase productivity.

2 Agrometeorology

To increase the use of climate resource information.

ENERGY RESEARCH

To assist in the conservation, production, and utilization of energy throughout the food production system.

1 Energy

To improve on-farm production and the use and conservation of energy.

ENVIRONMENTAL QUALITY RESEARCH

To minimize environmental hazards associated with agricultural production and practices.

1 Environmental quality

To develop agricultural management practices consistent with production and environmental requirements.

ANIMAL PRODUCTION DEVELOPMENT RESEARCH

To improve the efficiency of production and the quality of animals in support of market development.

1 Beef cattle

To improve the efficiency of beef production and the quality of beef products.

2 Dairy cattle

To improve the efficiency of milk production.

3 Swine

To improve the efficiency of swine production and the quality of pork and pork products.

4 Poultry

To improve the efficiency of production of eggs and poultry meat and the quality of poultry products.

5 Sheep

To improve the efficiency of sheep production and the quality of mutton and lamb products.

6 Other animals and bees

To improve the efficiency of production of other animals and bees, and the quality of their products.

CROP PRODUCTION DEVELOPMENT RESEARCH

To improve the efficiency of production and the quality of crops in support of market development.

1 Wheat

To increase production, protection, and utilization of wheat through multidisciplinary research.

2 Other cereal crops

To increase production, protection, and utilization of other cereal crops through multidisciplinary research.

3 Oilseed crops

To increase the efficiency of production, adaptability, and quality of oilseed crops and their products through multidisciplinary research.

4 Forage crops

To increase the efficiency of forage crop production systems and the quality of forage crops through multidisciplinary research.

5 Horticultural crops

To improve the efficiency of production and the quality of horticultural crops through multidisciplinary research.

6 Field crops

To improve the efficiency of production and quality of field crops such as tobacco, field peas, buckwheat, new crops, and field beans.

PRODUCTION SUPPORT RESEARCH

To ensure the availability and development of basic support services necessary for food and agricultural production.

1 Supportive research and development

To provide research information on crops, animals, and soils.

2 Protection

To provide new general research information on the protection of crops from diseases, insects, and weeds.

3 Biosystematics

To clarify the taxonomy of and provide identification services for vascular plants, insects, arachnids, nematodes, and fungi found in Canada.

FARM INPUT SUPPLY RESEARCH

To assist in ensuring the availability and quality of basic inputs to the food and agricultural production system.

1 Machinery and structural research

To provide information and technology needed for improving and better utilizing farm structures and machinery.

INTERNATIONAL DEVELOPMENT

To assist developing countries, directly and through international organizations, in becoming more self-reliant in food supplies and to provide assistance during food crises.

REGIONAL DEVELOPMENT

To facilitate development of the agri-food sector in each region—in accordance with its market potential—in collaboration with provincial government departments, federal departments, and nongovernmental organizations.

PROCESSING RESEARCH

To promote increased technological innovation and efficiency in the processing sector.

1 Processing technology

To develop new food processing technology and to improve the efficiency and effectiveness of food processing systems, including background research on the chemical and physical changes that take place during processing, and evaluation at a pilot-plant scale, as required.

2 New product development

To develop and characterize useful new ingredients or products for presentation to private industry for evaluation and application, and to develop the technology required to produce them, including evaluation at a pilot-plant scale, as required.

DISTRIBUTING—RESEARCH

To increase efficiency in the distribution sector.

1 Stored products

To improve the technology and effectiveness of off-farm storage of fresh fruits and vegetables, and to reduce losses in stored grains and oilseeds by controlling insects.

FOOD QUALITY AND NUTRITION RESEARCH

To ensure safety, quality, and nutritive value of edible agricultural products.

1 Food safety

To increase consumer protection by conducting research to reduce antinutritional factors and microbiological and chemical contaminants in agricultural products and food.

2 Nutrition

To assist in improving the general level of nutrition of Canadian consumers.

EXECUTIVE AND GENERAL MANAGEMENT

To provide managerial, financial, personnel, and administrative services required for the efficient management of the Branch.

TECHNICAL INFORMATION DISSEMINATION

To provide information on the agricultural and food system and ensure public awareness of Branch policies and programs.

STRUCTURE DU PROGRAMME DE LA DIRECTION GÉNÉRALE DE LA RECHERCHE

Objectif du Ministère

L'objectif fondamental d'Agriculture Canada, dans le cadre de l'ensemble des objectifs gouvernementaux et en collaboration avec les gouvernements provinciaux, est de développer le réseau agro-alimentaire canadien et de l'aider à répondre aux besoins des marchés national et étrangers, et à remplir ses engagements en matière d'aide international de manière à assurer: (*a*) aux consommateurs, un approvisionnement sûr d'aliments sains et nutritifs à prix raisonnable et (*b*) aux producteurs et aux transformateurs, une rémunération équitable.

Objectifs et sous-objectifs

TERRES

Contribuer à assurer le maintien, la disponibilité et l'utilisation optimale des terres agricoles de manière à répondre aux besoins actuels et futurs de la production agro-alimentaire.

1 Utilisation et conservation des sols

Parvenir à comprendre les propriétés qui limitent la productivité de certains sols.

2 Inventaire et évaluation des terres

Constituer un inventaire complet des sols canadiens et améliorer les méthodes permettant de les caractériser, de les classifier et de les évaluer.

EAU

Contribuer à l'utilisation plus efficace des ressources hydriques en production agricole.

1 Irrigation, drainage et dessalage

Améliorer les techniques d'utilisation de l'eau, d'irrigation et de drainage des sols canadiens afin d'en augmenter la productivité.

2 Agrométéorologie

Accroître l'utilisation de l'information disponible sur les ressources climatiques.

ÉNERGIE

Aider à la conservation, à la production et à l'utilisation de l'énergie dans tout le réseau de production alimentaire.

1 Énergie

Améliorer la production, l'utilisation et la conservation de l'énergie à la ferme.

QUALITÉ DE L'ENVIRONNEMENT

Réduire au minimum les torts causés à l'environnement par les operations agricoles.

1 Qualité de l'environnement

Élaborer des modes de gestion agricole compatibles avec les exigences de la production et celles de la protection de l'environnement.

DÉVELOPPEMENT DES PRODUCTIONS ANIMALES

Accroître l'efficacité de la production et améliorer la qualité des animaux de manière à favoriser l'expansion des marchés.

1 Bovins de boucherie

Accroître l'efficacité de la production bovine et améliorer la qualité des produits.

2 Bovins laitiers

Accroître l'efficacité de la production laitière.

3 Porcs

Accroître l'efficacité de la production porcine et améliorer la qualité de la viande et des produits dérivés.

4 Volaille

Accroître l'efficacité de la production d'oeufs et de volailles, et améliorer la qualité des produits avicoles.

5 Moutons

Accroître l'efficacité de l'élevage ovin et améliorer la qualité des produits du mouton et de l'agneau.

6 Abeilles et autres animaux

Accroître l'efficacité de la production des abeilles et autres animaux, et améliorer la qualité de leurs produits.

DÉVELOPPEMENT DES PRODUCTIONS VÉGÉTALES

Accroître l'efficacité de la production et améliorer la qualité des cultures de manière à favoriser l'expansion des marchés.

1 Blé

Poursuivre des recherches pluridisciplinaires afin d'améliorer la production, la protection et l'utilisation du blé.

2 Autres cultures céréalières

Poursuivre des recherches pluridisciplinaires afin d'améliorer la production, la protection et l'utilisation des autres cultures céréalières.

3 Oléagineux

Mener des recherches pluridisciplinaires afin d'améliorer l'efficacité de la production, l'adaptabilité et la qualité des oléagineux et de leurs produits.

4 Cultures fourragères

Poursuivre des recherches pluridisciplinaires afin d'augmenter l'efficacité des systèmes de production des cultures fourragères ainsi que la qualité de ces dernières.

5 Cultures horticoles

Améliorer, par le biais de la recherche pluridisciplinaire, l'efficacité de la production et la qualité des cultures horticoles.

6 Grandes cultures

Améliorer l'efficacité de la production et la qualité des grandes cultures comme le tabac, le pois, le haricot, le sarrasin et les nouvelles cultures.

APPUI À LA PRODUCTION

Assurer la mise au point et la disponibilité des services auxiliaires nécessaires à la production agroalimentaire.

1 Recherche et développement

Fournir des données scientifiques sur les cultures, les animaux et les sols.

2 Protection

Fournir de nouvelles données scientifiques sur la protection des cultures contre les maladies, les insectes et les mauvaises herbes.

3 Biosystématique

Clarifier la taxonomie et assurer des services d'identification des plantes vasculaires, des insectes, des arachnides, des nématodes et des champignons du Canada.

FACTEURS DE PRODUCTION AGRICOLE

Contribuer à assurer la disponibilité et la qualité des moyens de production fondamentaux au secteur agro-alimentaire.

1 Machines et bâtiments agricoles

Mettre au point les données et les techniques nécessaires à l'amélioration et à une meilleure utilisation des bâtiments et des machines agricoles.

DÉVELOPPEMENT INTERNATIONAL

Aider les pays en voie de développement, directement ou par le truchement d'organismes internationaux, à devenir plus autosuffisants en matière d'alimentation et à leur venir en aide en cas de crises alimentaires.

DÉVELOPPEMENT RÉGIONAL

Favoriser le développement du secteur agro-alimentaire dans chaque région—selon les capacités de leurs marchés—en collaboration avec les ministères des gouvernements provinciaux, les ministères fédéraux et les organismes non-gouvernementaux.

TRANSFORMATION

Favoriser l'innovation technologique et l'efficacité dans le secteur de la transformation.

1 Technologie de la transformation

Élaborer de nouvelles techniques de transformation alimentaire et améliorer l'efficacité des systèmes existants, y compris la recherche de base sur les modifications chimiques et physiques que subissent les aliments au cours de la transformation, ainsi que leur évaluation en usine pilote, le cas échéant.

2 Mise au point de nouveaux produits

Mettre au point et caractériser de nouveaux ingrédients ou produits utiles en vue de les faire évaluer et fabriquer par le secteur privé et mettre au point également la technologie nécessaire à leur production, y compris l'évaluation en usine pilote, le cas échéant.

DISTRIBUTION

Accroître l'efficacité du secteur de la distribution.

1 Produits entreposés

Améliorer les techniques et l'efficacité de l'entreposage des fruits et des légumes frais à l'extérieur de la ferme et réduire les pertes de céréales et d'oléagineux dans les entrepôts par une lutte soutenue contre les insectes.

QUALITÉ ET VALEUR NUTRITIVE DES ALIMENTS

Voir à la salubrité, à la qualité et à la valeur nutritive des produits agricoles comestibles.

1 Salubrité des aliments

Augmenter la protection du consommateur par des recherches visant à réduire les facteurs antinutritionnels et les contaminants microbiologiques et chimiques dans les produits agricoles et les aliments.

2 Nutrition

Contribuer à améliorer en général le régime alimentaire du consommateur canadien.

DIRECTION ET GESTION GÉNÉRALE

Fournir les services nécessaires dans les domaines de la gestion, des finances, du personnel et de l'administration afin d'assurer une gestion efficace de la Direction générale.

DIFFUSION DE L'INFORMATION TECHNIQUE

Diffuser de l'information à l'intention du circuit agro-alimentaire et s'assurer que le public est au courant des politiques et des programmes du Ministère.

CAL/BCA OTTAWA K1A 0C5
3 9073 00208464 0

DATE DUE

MAR 1 9 2010

GAYLORD

PRINTED IN U.S.A.